2017
PUBLIC-PRIVATE
ANALYTIC EXCHANGE PROGRAM

Communication Tools to Increase Communities' Resilience

August 31, 2017

A Case Study of the Oroville Dam, CA

Table of Contents

I.   Executive Summary

Within the emergency management community, it is widely recognized that effective public communication of hazard information during crises is a critical factor for minimizing casualties and economic loss, and in ensuring local communities successfully recover from the impact of extreme events. The processes by which communities avoid, mitigate and recover from damage due to disaster (i.e. *community resilience*), and the methods that organizations can employ to encourage this outcome, are of increasing interest. This report, intended for emergency management stakeholders at all levels who are charged with crafting and disseminating emergency warning messages, is meant to increase awareness of communication tools, strategies and practices that may contribute to resilient outcomes for communities at risk to a variety of hazards.

To identify effective government-to-community communicative practices for rapid-onset emergencies, a research team sponsored by the Department of Homeland Security conducted a case study involving Butte, Sutter and Yuba Counties in California where the February 2017 Oroville Spillway incident prompted an emergency evacuation order affecting 200,000 residents. The team's goals were to inventory the communication tools and processes utilized by emergency managers to transmit evacuation messaging to community members, and to glean a variety of perspectives on which of these tools and processes had informative and resilience-enabling characteristics.

Through interviews with local emergency managers, informal surveys of local community members, and the research team's literature review, several key observations and recommendations for emergency communications emerged:

- To gain public trust and encourage compliance with official protective action orders, messages should be coordinated with, and if possible transmitted by, well-known and trusted public figures who command significant community respect.
- Combatting rumor and false information on social media during emergencies is very time- and resource-consuming, yet emergency mangers can mitigate the effects of rumors by message preemption (being *first*) and message consistency (being *credible*).
- A mixture of communication platforms and messaging formats should be deployed in order to leverage the strengths and mitigate the weaknesses of each, and to ensure maximum dissemination in social systems with varying levels of technological savvy and access.
- Inter-agency operational partnerships and resource/facility-sharing agreements can help make emergency communications operations resilient to common disaster contingencies such as facility evacuations or service outages.
- Planning for 'last-mile' emergency message transmission to vulnerable, remote or special-needs community populations – a crucial step in emergency management – can be accomplished through public-private partnerships and community engagement activities.

In addition, the research team's findings shed light on key improvement recommendations for coordination between dam owners/operators and the emergency management jurisdictions charged with responding to dam-related hazards. Together, the inventory of these communication tools and practices, and the lessons learned from real-world application, provide additional insight on the role disaster and emergency communications play in building or sustaining community resilience.

II. Introduction

Communities become more resilient to various man-made and natural hazards by adopting strategies and conducting activities in advance of and in response to specific catastrophic events. The Department of Homeland Security (DHS) Analytic Exchange Program (AEP) Community Resilience Team ("Team") reviewed and inventoried strategies and activities related to evacuation behavior (both alerting and warning) in order to determine how different types of communication channels may impact the resilience of communities. One goal of this project was to collect an inventory resource of common practices on evacuation messaging (output and uptake), and their effectiveness in encouraging action among community members.

A general assumption by policy-makers and emergency managers is that an "all-hazards" approach to consequence management assists communities in identifying actions that mitigate and/or eliminate the impacts of a full range of threats and hazards that might lead to catastrophic events. This is not a "one size fits all hazards" approach. The principles of emergency planning works for all hazards, but the uniqueness of each hazard needs to be addressed and documented in the planning process. This is true, regardless of the threat or hazard, as taking steps to plan response actions that provide for quick resolution helps to create more resilient communities. Communication is key to community resilience and key to achieving success in preventing, protecting, mitigating, responding, and recovering from any hazard(s) that communities might face. There are many resources regarding hazard communications; however, strategies that influence community resilience underscore the need for further research in determining how community members learn about impending events and actions that they can take to increase their individual and community resilience.

Research associated with the uptake of messaging through specific communications channels can provide needed insights into how different segments of community populations learn, assimilate, and further disseminate information. Lessons learned from previous disasters provides quantitative benchmarking data, as well as qualitative information that can inform strategies that may influence community resilience. To that end, this report provides the results of the AEP research team efforts that focused on a case study of Oroville, CA in which the communication tools utilized during the February 2017 evacuation activities were assessed. During an evacuation, effective communications are critical to public safety. The incident may cause significant disruption to the area's critical infrastructure, hampering evacuation operations. Federal assistance is provided in response to a State request for assistance in the face of a State or locally mandated mass evacuation. It is coordinated with State, tribal, or local governments.

As witnessed in Oroville and during other emergencies requiring evacuation, the need for effective crisis communications is critical. The increase and uptake of new technologies provides for additional support in the area of crisis communications. For instance, the First Responder Network Authority (FirstNet), created in 2012 as part of the "Middle Class Tax Relief and Job Creation Act of 2012," enables emergency responders and safety officials access to the first nationwide, high-speed, broadband network dedicated to public safety. In early 2017, AT&T partnered with FirstNet to construct this network over the next five years and continued collaboration and development under a 25-year contract.[1] This partnership has already provided individual plans to rapidly deploy the FirstNet communication system to 56 U.S. states and territories (see Figure 1 below). Currently, in order for safety officials to opt-in to FirstNet the Governor of the state or territory must agree to participate. Twelve states and territories have already

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[1] / Douglas, T., (19-JUN-2017) *GovTech*, "State, Territory Plans and Next Step in FirstNet Build-Out Arrive Ahead of Schedule" Web., http://www.govtech.com/public-safety/State-Territory-Plans-Next-Step-in-FirstNet-Build-Out-Arrive-Ahead-of-Schedule.html

decided to participate. Virginia and Wyoming were the first to opt-in on July 10, 2017, and on August 8, 2017, Montana opted-in on FirstNet.[2]
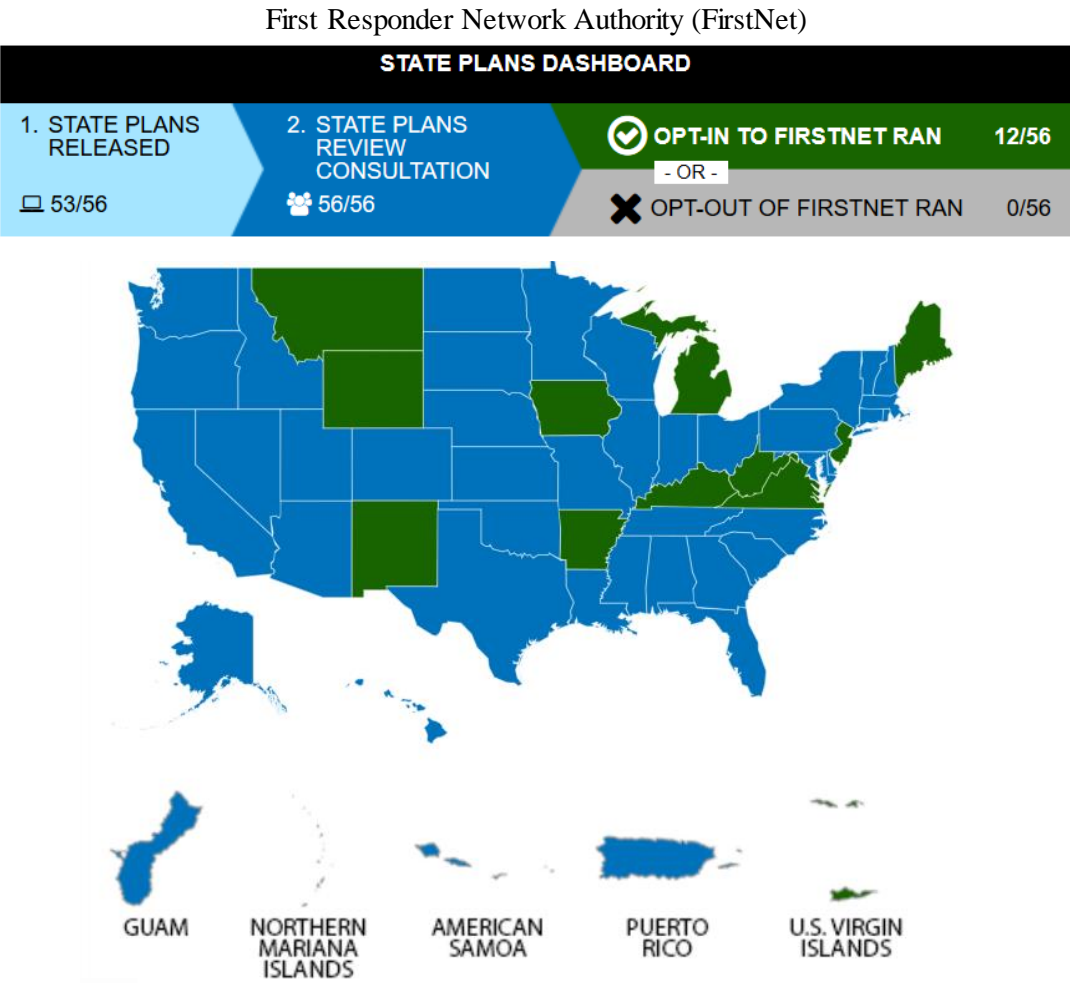
First Responder Network Authority (FirstNet)

At the time of this report, California was not on the "Opted-in" list; however, the Butte County, CA pre-packaged warning and evacuation orders notification system utilized during the Oroville Spillway incident allows for county residents with AT&T service auto-enrollment in notifications. A recent National Governor's Association report noted that state Governors should

> *"ensure that evacuation plans are fully operable and that they describe the conditions necessary to initiate, execute, and cease an evacuation or a shelter-in-place strategy; establish clear, unified command and control authority; operational strategies; and sound communication procedures; establish evacuation roles and responsibilities across state agencies, federal government, and NGOs; and understand the terminology used to implement evacuations, their potential effect on participation rates, and the legal implications of different types of warning orders."[3]*

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[2] / FirstNet (2017) https://www.firstnet.com/power-of-firstnet/how-do-i
[3] / National Governor's Association (2014) *Governor's Guide to Mass Evacuation*, Web.
https://www.nga.org/files/live/sites/NGA/files/pdf/GovGuideMassEvacuation.pdf p. 7.

The NGA report additionally emphasized the need for "us[ing] the widest array of communication methods possible to ensure that the public receives vital information during disasters."[4]Whether national, regional, or local communication tools are employed, this study provides a snapshot of a wide variety of communication tools utilized during the February 2017 incident.

III.   Background and Context

In early 2017, the Lake Oroville spillway sustained serious damage following a flurry of storms and record rainfalls. According to the California Department of Water resources, it was the wettest January and February in 110 years of Feather River hydrologic record[5]. Lake Oroville received a year's average of runoff within approximately 50 days.

While the Oroville Dam was never at risk of failure, an emergency spillway designed to be used as an emergency control outlet in the event of high reservoir levels appeared to be at risk as underlying concrete eroded at an extremely rapid pace on February 7, 2017. More details on the chronology, decisions taken, and chain of events can be found in the various presentations noted in the bibliography. Following the record rainfall and subsequent spillway damage, approximately 188,000 residents were ordered to evacuate, making this one of the largest peacetime non-hurricane mass evacuations in U.S. history. This evacuation provides the unique opportunity to learn more about how individuals receive information and translate it into action.

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[4] / Ibid., p. 8.
[5] Photo from presentation on the Oroville Gated Spillway and Emergency Spillway Incident, California Department of Water Resources.

Oroville Spillway Incidents Timeline of Events[6]

❶ **February 7:** As water releases from the flood control spillway ramp up to 54,500 cubic feet per second (cfs), in anticipation of inflows expected from rainfall, DWR employees notice an unusual flow pattern. Spillway flows stop for investigation. Engineers find large area of concrete erosion.

❷ **February 8:** DWR begins ongoing consultation with FERC and other dam safety agencies. DWR runs test flows down the damaged spillway, monitoring further erosion, and prepares for possible use of emergency spillway. 24/7 emergency interagency operations centers activate to study and implement response to flood control spillway and related structures, with careful study of weather forecasts.

❸ **February 11:** Inflow to Lake Oroville brings lake level above 901 feet. This engages the emergency spillway for the first time in the history of the facility.

❹ **February 12:** Anticipated erosion begins to progress faster than expected at the base of the emergency spillway. The Butte County Sheriff's Office issues mandatory evacuation orders for the Oroville area. To ease pressure on the emergency spillway, the flood control spillway outflow is increased to 100,000 cfs. After several hours, inflows decrease and overflow stops at the emergency spillway. Erosion to the emergency spillway hillside is assessed.

❺ **February 13:** DWR crews begin working around the clock to repair the emergency spillway. Evacuation orders remain in effect.

❻ **February 14:** As the lake level continues to drop, the mandatory evacuation order is modified to an evacuation warning. Crews continue working around the clock to repair the emergency spillway. An elevation of 850' is targeted for lake level.

❼ **February 16:** Flood control spillway flows are reduced below 100,000 cfs to facilitate the clearing of debris from below the spillway. Lake levels continue to drop. Construction to armor the emergency spillway continues.

❽ **February 18:** Lake level down to 854 feet. Flood control spillway flows are reduced to 55,000 cfs. Barge construction begins in order to remove debris from the diversion pool beneath the spillway.

❾ **February 20:** Lake Oroville elevation reaches 848.95 feet at 11 a.m. Repairs and preparations continue around the clock.

water.ca.gov
cdec.water.ca.gov/
reservoir.html
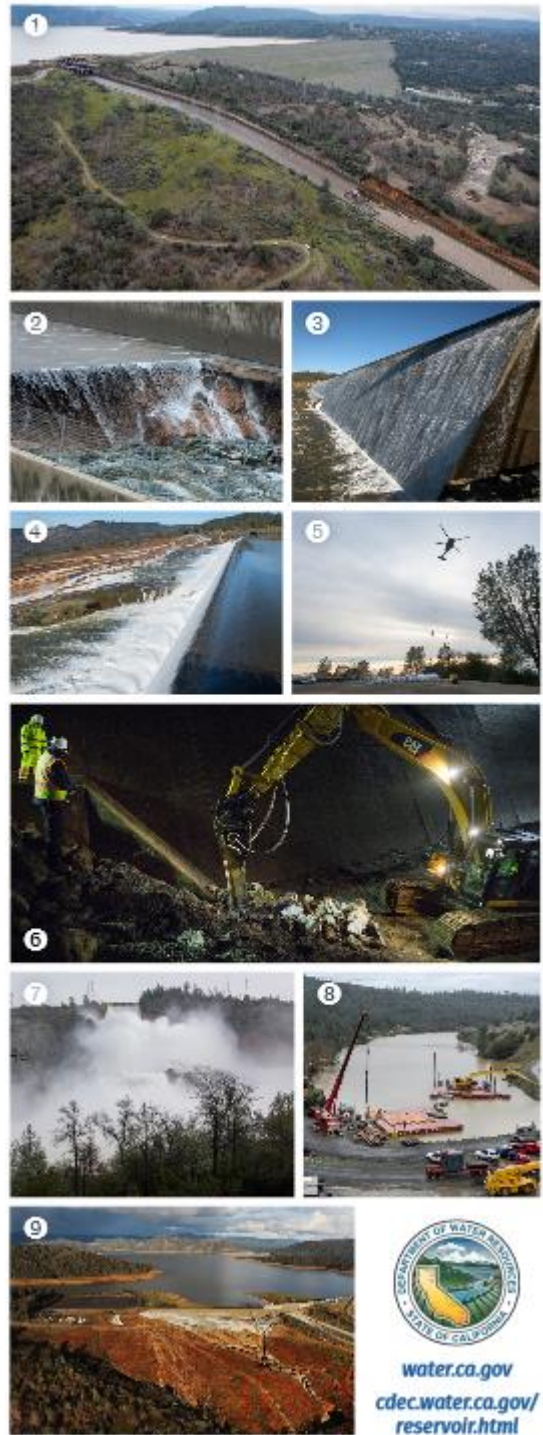
[6] / California Department of Water Resources (2017) "Lake Oroville Spillway Incident: Timeline of Major Events February 4-25" Web.
http://www.water.ca.gov/oroville-spillway/pdf/2017/Lake%20Oroville%20events%20timeline.pdf

During the period March – June 2017, the DHS AEP Community Resilience Team conducted a variety of interviews – including site visits in Butte, Sutter, and Yuba counties in June 2017 – to learn about the communications tools used in evacuating the communities around the Oroville Dam in February 2017. [7]

It is important to note what these interviews "*were not*".

- The Team did not conduct a "hot-wash" evaluation of the decisions made (e.g., requiring evacuation of the downstream areas that potentially impacted following a dam or emergency spillway failure).
- The Team did not assess and assign blame or praise for the decisions made.
- The Team did not assess the inter- and intra-agency communications, preferring to focus on the communications from an agency or "someone in the know" to the general public. This included both the official and unofficial notification processes.
- The Team did not assess a critical process – how to deal with rumors and misinformation shared via various notification processes. As these processes rolled out, it was a certain amount of subjectivity, and even concern that some of these processes it might be fake quotes or not properly informed.

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[7] Photos from presentation on the Oroville Gated Spillway and Emergency Spillway Incident, California Department of Water Resources.

The Team chose the Oroville situation as, at the time, it was the largest "peacetime" non-hurricane related evacuation in U.S. history as it is estimated that over 160,000 of the 188,000 requested evacuations took place. There is some debate as to whether the evacuation was "successful" as it is clear that not all would have been able to evacuate successfully had the Emergency Spillway failed in the hour, as it took some evacuees 12-16 hours to escape the potential inundation zone. Once again, the Team refrained from asking questions as to the efficacy and success of the evacuation, as it was beyond the Team's mandate.

Rather the Team focused on attempting to understand what finally motivated citizens to take action and evacuate. During the event, the communities were besieged by a variety of data elements, often conflicting and confusing. The communities needed to synthesize this disparate data into specific knowledge, and finally had to take this knowledge and translate it into action. Making the difficult decision to evacuate requires knowledge and sifting through lots of data, and becomes more difficult as members of modern society are often bombarded by multiple and sometimes conflicting data sources.
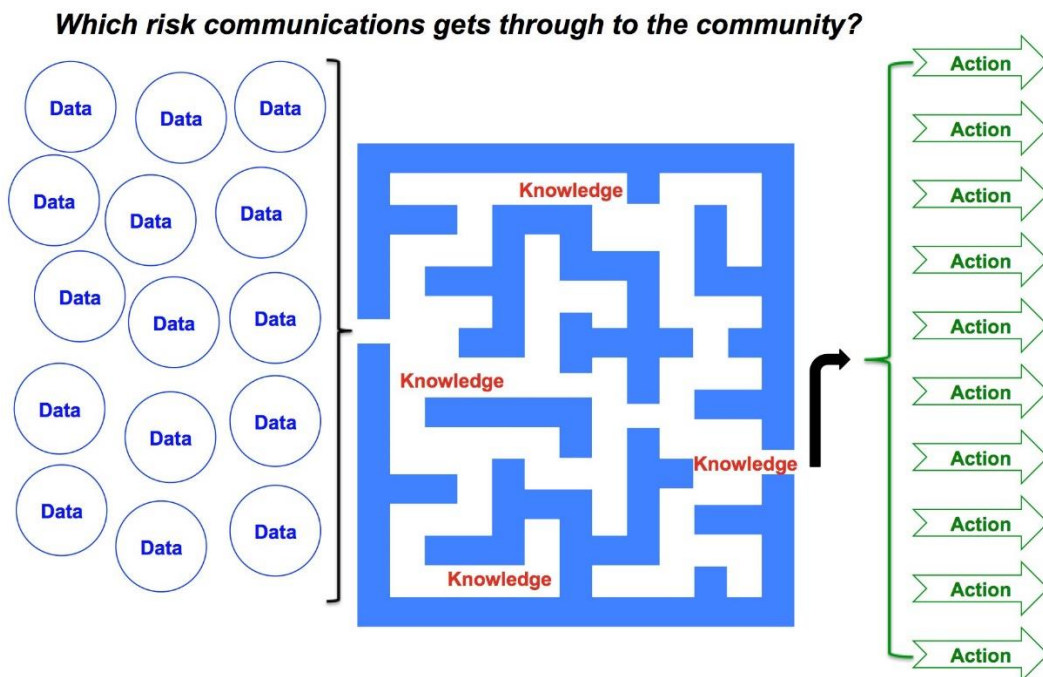
While the number of survey respondents was significant, the Team's analysis was also not a statistically robust analysis. Rather our observations and conclusions were based on a selected number of interviews, an extensive literature search and the impressions and opinions expressed by various participants and citizens involved in the situation. In order to conduct a more robust analysis, additional resources, both time and money, and a more disciplined approach would be required. However, lessons learned from this experience in this analysis, anecdotal in nature as they may be, can be the basis for identifying leading practices and lessons learned that can be applied across a broad array of natural and man-made disasters in the future.

These interviews were supplemented by literature reviews and a voluntary on-line survey – distributed by the Butte, Sutter and Yuba County Emergency Responses Offices – conducted with community members in Butte, Sutter, and Yuba counties during the period July 11, 2017 through July 24, 2017. It is important to note that while a significant number of survey responses were received (n = 2,095), it might have been higher as for the first week of the survey period, many Butte County residents evacuated their homes and businesses due to risk of wildfires.

III.   Initial Observations

There is a strong body of literature focused on preparedness that should be leveraged since it is analogous to the work that we are doing around communications notification. Some of the most interesting and clearly articulated work has been conducted by Dr. Dennis Mileti and draws from two of Dr. Mileti's studies.[8]

When considering the Oroville event, it is important to differentiate between "alerting" and "warning". "Alerting" serves to get people's attention that there is a potential hazardous situation. Traditionally, communities were alerted via several old-fashioned responses, such as air raid sirens, while contemporary approaches including using IPAWS, CAP, CMAS, and using cell phones and other devices to get people's attention and provide mini messages. "Warning" is used to provide public messages and information to motivate the public to take timely and protective actions.

As the Oroville case focused on communication tools and how they worked – defined in how effective they were in helping people to make decisions to evacuate – the Team did not differentiate between alerting and warning. This was especially relevant as the time period between the identification and realization of the potential issue and the need to get people to evacuate was fairly compressed – less than an hour – and did not allow for differentiation between alerting and warning.

Given the diversity of the populations in the three counties – including socioeconomic, language, cultural, age, gender, home ownership/homelessness status, familiarity with technology, etc. – there may not be an optimal solution that works for everyone and during events, those looking to alert/warn other may require multiple solutions.

- To better illustrate the diversity of the population, there were several subpopulations where English was not the primary language spoken – including communities of Hmong, Vietnamese, Spanish, Chinese and Punjabi speakers – and the notifications were predominantly conducted in English. It is important to note that the survey results might be skewed as Question 10 in the survey ("*Is English the only language spoken at home?*" 89.7% of the respondents (or 1,774 of the 1,979 question respondents) answered "Yes" as the survey was only issued in English.
- Given the high homeless population (especially in encampments along the Feather River), it was important for public safety officials to get out and use loud speakers to communicate the need to evacuate to the homeless population.

As in other emergency events, there was a significant amount of "social milling", where people hearing of the evacuation felt the need to verify the source and accuracy of the information, Accordingly, it is important for the messages to be very precise in terms of including basic information such as source of the notification, the specifics of the emergency, the timing of the event and requested actions, and specific recommendations and that the local citizenry follow.

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[8] Dennis S. Mileti, December 20, 2007 – "*Public Education Research Findings and Evidence Based Applications for Practice" A Briefing on Public Education for Household Disaster Readiness, START Center, University of Maryland, A DHS Center of Excellence for Research on Terrorism*", December 20, 2007 and Dennis S. Mileti, March 2012 – "*Public Disaster Warnings - Highlights of Repetitive Findings From The Social Science Research Record, University of Colorado, Boulder, Presented to the Workshop on Public Response to Alerts & Warnings via Social Media, National Research Council of the National Academies*", Irvine, CA February 28, 2012, National Consortium for the Study of Terrorism and Responses to Terrorism.

IV.   Specifics on Communication Tools

Initial in-person interviews provided the Team with an understanding of the extensive communications network that currently exists to provide Californians with access to emergency notifications during emergencies. The CA 9-1-1 emergency communications provides "public safety answering points (PSAPs) to provide expedient telephone access to emergency services for all 9-1-1 emergency callers by assisting PSAPs in the administration and funding of this lifesaving resource in their communities."[9] The Public Safety Communications (PSC) provides the infrastructure for the content; and does not provide for the content itself. They interact with Emergency Support Function 2 (ESF-2 – Communications Annex). PSC distributes information. PSC also has the reverse 9-1-1 system. PSC keeps the 9-1-1 lines open for other purposes. PSC is the 9-1-1 system Administrator. PSC knows how many 9-1-1 calls are being made. The 9-1-1 call system supports many languages. At one central point, anyone anywhere in CA can make a call and the system routes the call to the right dispatch center. PSC provides the infrastructure for communications between agencies.

During the Oroville Spillway incident, Butte County and Placer County assisted in handling 9-1-1 calls. Provision of emergency alert calls was coordinated at the local level. The phone carriers were responsive. Wire-line calls were in call-back capacity and automatic, wireless calls needed to manually respond. To ensure coverage, it can take hours, if not days, to call everyone and this is a function of the population size. Text services work faster due to less bandwidth requirements that allow for less tie up on the trunk lines. Notifications are provided via tree systems – regional distribution system, and a pipeline is necessary to support the emergency alert system. Fire Service has VHF for Emergency and Medical use. There is an emphasis on state and local government officials thinking regionally and working with other officials and agencies to ensure effective communications. During an evacuation, it can be hard to shake hands with the public – including regional dispatch centers and backup centers. Variability is a necessity – the AEP Community Resilience Team would need to understand additional considerations, such as administrative lines, community lines, websites, text notifications, foreign language content (e.g., ~22,000 calls per month are not in English in CA), and accessibility for the deaf and other impaired communities, as well as texts to 9-1-1 (441 PSAPs, 68 take text – all have plans or are accepting them.) Additionally, not all radio stations have inoperability, and while many on the emergency services side do have inoperability, there are significant challenges in capacity and time constraints to program them all with the same information.

Of note, Butte County, CA has a pre-packaged warning and evacuation orders notification system. The orders are web-based, and community members can opt-in to hear a new language. County residents with AT&T service are auto-enrolled; all others need to self-enroll. The pre-packaged warning evacuation order can send out texts, emails, and phone calls. Additionally, Butte County has the Special Needs Assistance Program (SNAP). SNAP gave Butte OES "good awareness of vulnerable populations" before the evacuation, and allows first responders to distribute in-case-of-emergency packets to these residents as a mitigation/preparedness measure throughout the year. During the Oroville evacuation, this allowed for OES to provide CalFIRE and the Sheriff intelligence about vulnerable populations to support evacuation operations. In Oroville, Butte County social media served as an important communication vehicle during evacuation, primarily to retweet/share Sheriff Office social media postings. In doing so, postings focused on "getting out the right information" instead of combatting false information. While text messaging is considered more efficient than phone calls, there is a need for additional human personnel to combat rumors on social media. The Butte County Emergency Notification System runs through the Butte County Sheriff's Department. Butte County call center was shared with Paradise City. There were also radio, TV, and other media messages distributed during evacuation

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[9] / CalOES (2017) Web., http://www.caloes.ca.gov/cal-oes-divisions/public-safety-communications/ca-9-1-1-emergency-communications-branch

("THIS IS NOT A DRILL, THIS IS NOT A DRILL…"). Post-evacuation after-action noted an anticipated "Know Your Zone" initiative planned for Oroville.

Existing relationships with local communications outlets provided for easier coordination during the emergency. Butte OES' and the Sheriff's existing relationship with the local AM radio advisory council made it easier to coordinate and send out official messages on that medium. Cross jurisdictions relationships were important.

In Sutter County, Nixle is employed – a subscription mass emergency notification system (that can notify via text, or email). Prior to the Oroville crisis, 4,600 people signed up for the service. After the Oroville crisis, an estimated 27,000 residents signed up for the system. Additionally, Yuba City's Rapid Notify was utilized, which had land line capabilities; after action planning noted an upgrade to a more robust Nixle product that has landline notification capabilities and geo targeting, or some other system with all of those capabilities.

V. Methodology

While it is difficult to extrapolate consistent strategies across different hazards and communities, the AEP Community Resilience Team explored the tools or methodologies communities use for assessing imminent or actual threats or damage; raising awareness on threats, behaviors, indicators; increasing vigilance; and encouraging preparedness. The team conducted a literature review, conducted in-person interviews with key Oroville Spillway stakeholders, and released a survey to the general public to gain supplemental information. More information about the three methods of data collection is outlined below.

1.   Literature Review
The Team:

- Identified similar evacuation scenarios to Oroville, what has already been done in terms of hotwashes/lessons learned, and any resulting communication strategies that were implemented to improve community resilience;
- Identified any research that has been done more broadly on what influences an individual's decision-making process in response to evacuation messaging;
- Conducted a literature review to assess earlier work, both to inform our efforts and to help ensure that they are not duplicative/redundant and are contributing to the current body of work in this area; and
- Based upon the literature review, articulated what this report contributes to the body of resiliency research through our project and who our deliverable is intended for.

2.   Stakeholder Feedback

The team conducted in-person research in Oroville, CA in attempt to assess:

- Emergency public communication procedure(s) developed
- Public notification and messaging procedural testing
- Actual or impending incident response taken
- Authorized agencies involved emergency response
- Demographics
- Type of warning, notifications, and communications by area
- Accessibility
- Community engagement

In-person interviewee organizations included:

1. Public Safety Communications, California.

2. Department of Water Resources, California.
3. Butte County, California Office of Emergency Management.
4. California Governor's Office of Emergency Services.
5. Butte County Fire Department, California; and CalFIRE Department.
6. California Office of Emergency Services.
7. Sheriff, Butte County, California.
8. Butte County Local Agency Formation Commission.
9. Sutter County, California.
10. Yuba County, California.
11. California Earthquake Authority.

3.   General Public Survey

As noted earlier, the Team derived its information, made observations and recommendations on a select number of interviews, some survey results, and extensive reading of existing literature. The survey questions were developed by the Team that worked to balance survey brevity with looking for specific information on respondent demographics, respondents' experience during the event, and respondents' future anticipated actions.

Full results of eleven of the twelve survey questions can be found in Appendix B. The 12th question, which was an open-ended question that asked respondents to provide any thoughts, comments or ideas related to the evacuation communications is separately available. While the quantitative responses are provided as received, the qualitative responses were scrubbed for to address privacy issues (taking out email and phone number information, some personal medical discussions), and some coarse language which might have been offensive to some readers. A select number of responses is provided both in the call out boxes below and in the table in Appendix A.

The Team chose the Oroville situation as it was the largest "peacetime" non-hurricane related evacuation in U.S. history as it is estimated that over 160,000 of the 188,000 requested evacuations took place. There is some debate as to whether the evacuation was "successful" as it is clear that not all would have been able to evacuate successfully had the Emergency Spillway failed in the hour, as it took some evacuees 12-16 hours to escape the potential inundation zone.

We recognize that the summary survey response period was limited to two weeks, that is was biased as the survey was only put out in English and only put out the notification for those people who had enrolled themselves in local county emergency operations Facebook or Twitter notification systems. That being said some notable trends emerged including:

- The number of respondents over a relatively short survey time period and with limited outreach efforts;
- The high percentage of people who completed the survey, including providing extensive qualitative comments in response to the open question;
- The breadth and depth of the qualitative comments, ranging from extremely critical to extremely positive, including suggestions for future actions and improvement opportunities; and

While the survey instrument and the inventory focused on the Oroville situation, the report is intended to be extrapolated to address non-Oroville dam-related events including potential natural and man-made hazards (such as storms, earthquakes, terrorist attacks, etc.)

VI. Literature Review

A. The role that public communication tools play in community resilience during disasters

For well over 40 years in the U.S., scholarship across the social sciences has been directed toward assessment of the effectiveness of public emergency communications, and in answering, for the benefit of academic as well as government audiences, the fundamental question of 'What qualities of emergency warning messages seem to enable citizens to protect their lives and property during disasters?' Conceptual frameworks for approaching the study of emergency communications, and public response to these messages, are generally agreed to have originated within the field of sociology in the 1970s in survey-based, post-disaster, household-level behavioral analysis (Quarantelli 1978, Dynes 1970, Mileti et al 1977, NRC 2006). At the end of the 20th century, a sense of urgency for new risk, hazard and disaster communications research which could inform emergency management policy was prompted by several concurrent national and international events. Internationally, the U.N. General Assembly's declaration of the 1990s as the 'International Decade for Natural Disaster Reduction' prompted a refocusing of research agendas toward disaster preparation and response in general, and the development of disaster communication technologies and early warning systems in particular (Lechat 1989, Montz et al 2003).

B. Common perspectives re: communication tools that focus on communities

During the same time, within the U.S., comprehensive assessments of the country's hazard warnings infrastructure found that:

- Systems for prediction & forecasting, warning integration and warning dissemination were fragmented, non-interoperable and unevenly developed (ORNL 1990) (Sorensen 2000).
- The process of emergency communications planning often included relatively little bi-directional engagement between governments and local communities, or between government agencies (NRC 1989).
- The content of warning messages, including recommended protective actions, were often crafted under false assumptions about human risk perception or myths about crisis behavior (Quarantelli 1997, Sorensen 2000).
- Warning infrastructure was generally slow in evolving with emerging telecommunications technologies (NRC 2001).

These deficiencies drew the attention of federal entities responsible for driving science and technology research policy, who included public hazard and disaster communications as part of several 'Grand Challenge' research initiatives in the first years of the 21st century (POTUS/NSTC 2005) (NRC 2005). Research communities across the social and natural sciences have since responded to this call, and during the past 15 years the following main research foci have emerged:

- How communities use new telecommunications technologies (i.e. SMS systems), social media (i.e. Twitter) and volunteered geographic information (i.e. OpenStreet Map) to communicate hazard information among themselves and to outside organizations/emergency managers (Latonero & Shklovski 2011) (Liu et al 2008) (Mark & Semaan 2008) (Palen et al 2009) (Palen et al 2010).
- Communities as complex 'systems-of-systems', and community resilience defined within the context of socio-ecological systems theory (Folk 2006) (Liu et al 2007) (Berkes & Ross 2014), including how models of information flow within such systems can be used to optimize community hazard awareness and disaster warning dissemination (Goldstein 2009) (Rogers et al 2016).
- Systems, protocols and best-practices that enable end-to-end, cross-sector information sharing and whole-of-government situational awareness for each stage of the disaster cycle (NRC 2012a) (Williams & Seeger 2005) (Covello 2003) (Myers & Grant 2010).

- Systems, protocols and best-practices that enable risk, hazard, disaster and recovery information to reach special-needs or highly vulnerable community members (Taubenbock et al 2009) (Lindell & Perry 2003) (Scott & Coleman 2016) (Wells et al 2013).
- Individual-, community- and organizational-level perception of and behavioral response to disaster warnings and other types of hazard communications (NRC 2006) (Dash & Gladwin 2007) (Lindell & Hwang 2008) (Kellens et al 2013).
- Computer modeling and simulation of human evacuation behavior, diffusion of warning messages in social networks, and spatio-temporal effects of various disaster scenarios (Cuesta et al 2015) (Helbing & Balietti 2011) (Murphy & Flournoy 2002) (Reuter et al 2009).

Throughout these developments, hundreds of large- and small-scale disasters tested the nation's early warning and disaster notification systems as well as governments' emergency communications plans and procedures. The outcome of these events offered researchers opportunities to empirically assess the effectiveness of various communication strategies and technologies, investigate the public's response to warning messages, and to ultimately convey best practices in emergency information sharing for a variety of hazards (natural and man-made environmental hazards, health crises, security-related emergencies, etc.). In particular, recommendations for the content and delivery of emergency alerts, based on case studies of actual disaster events, have proliferated in the research (CDC 2014). Table 1 offers a high-level overview of these main recommendations and insights related to evacuation messages for riverine flooding or dam failure-related hazards.

However, it has been recently noted that best communication and emergency warning practices are likely case- and place-specific, with significant variability in 'what works' according to geographic context, local hazards profile, community socioeconomic characteristics, local technology infrastructure and other context-dependent factors (CDC 2014, NRC 2015b). The following research gaps are specifically identified in recent national-level research:

- Qualitative and quantitative assessments of optimal place-based organizational arrangements that facilitate cross-sector information sharing and public information dissemination (NRC 2012, NRC 2015a, NRC 2015b, FEMA 2013, FEMA 2015).
- Qualitative and quantitative assessments of ways local government agencies, emergency managers and/or elected officials can monitor and manage social media during disasters, including minimizing rumor and misinformation (NRC 2015a).
- Case studies of effective local community usage of established and/or emerging telecommunications and web technologies (SMS, social media, specialized EWS, apps, volunteered geographic information, etc.) to receive hazard warnings and disaster information (NRC 2011, NRC 2013).
- Case studies of best practices for communicating hazard information and disaster warnings to at-risk, socially vulnerable or special needs community members (NRC 2015a, NRC 2015b, FEMA 2013).

C. Current research gaps and how this project fills them

Additionally, the emerging realization that many communities and jurisdictions do not have the resources to put into place all the resilience-boosting communication measures recommended by the literature (see Table 2) necessitates that future research should identify best practices in how communities strategically deploy resilience-building measures given these resource constraints.

TABLE 1. Insights from Disaster Communications Research into Qualities of Effective Warning Messages for Flood and Dam Failure Related Hazards

Research Insight	Case Studies
There is no single, one-size-fits-all evacuation warning message (or message platform) which is appropriate for all flooding or dam failure-related hazards	Multiple Events (Sorensen and Mileti 2000, Mileti and Sorensen 2016)
Having a strong social network increases the likelihood of a person responding to a warning message.	12 Mile River, UT Dam Failure (Anderson et al 1984); Denver, CO Flood (Worth et al 1977)
The more consistency with which a warning message is delivered across multiple platforms, the more likely the receiver is to believe it.	Rio Grande, TX Flood (Clifford 1956); Big Thompson River, CO Flood (Gruntfest 1977) Cheyenne, WY Flood (Sorensen 1987); Multiple Events (Perry 1983, Gruntfest and Huber 1989, Baker 1991)
If repeated confirmation of the disaster/hazard occurs from and authoritative and trusted source, people are more likely to believe and respond to a warning message.	Port Jervis, NY Flood (Danzig et al 1958); 1965 Denver, CO Flood (Drabek 1969); Multiple Events (Gruntfest 1997)
The more specific a warning message is, the more likely the receiver will believe and respond to it.	1965 Denver, CO Flood (Drabek and Boggs 1968); 1978 Fillmore, TX Flood (Lindell 1980); Rapid City, SD Flood (Mileti and Beck 1975); 1981 Austin, TX Flood (Moore et al 1982) Multiple Events (Carter 1980, NRC 2015a)
Warning messages delivered via a local communication medium (i.e. local radio) are more likely to be believed and responded to.	1965 Denver, CO Flood (Drabek and Stevenson 1971); Multiple Events (Frazier 1979, Coile 1997)
Having had hazards experience increases the likelihood of a person personalizing a warning message.	Rapid City, SD Flood (Hutton 1976); Tucson, AZ Flood (Saarinen 1984); Multiple Events (Perry et al 1980, Hansson et al 1982)
The more knowledge people have about the protective action being recommended in a warning message, the more likely they are to respond to the message.	Multiple Events (Perry 1979, Leik et al 1981, Perry et al 1983, Lindell and Perry 1987)
'False alarm' warning messages probably do not affect people's decision to heed future warnings, unless they are repeatedly issued many times	Grafton, IL Flood (Pfizer 2002); Multiple Events (Dow and Cutter 1998, Mileti and Sorensen 2016)
Warning messages and/or situational updates that are empathetic, reassuring or stress-reducing in tone are more likely to be personalized by the public	Multiple Events (Covello 2003, Reynolds and Seeger 2005, Seeger 2006, CDC 2014)
Inclusion of, or linking to, inundation map(s) related to the flood hazard increases the likelihood of citizens personalizing the warning message	Multiple Events (NIST 2003, NRC 2012, NRC 2013a, NRC 2013b CDC 2014, NWC 2016)
The farther away the location of the hazard mentioned in the warning message, the less likely citizens will personalize the message	Multiple Events (Frazier 1979, Perry 1981, Rogers and Nehnevajsa 1987, Lindell and Perry 2004)
Choices of warning message platform and content should take into account special community characteristics such as age, disability status, ethnicity, language, access to transportation infrastructure, economic vulnerability, and others	Multiple Events (NIST 2003, Lindell and Perry 2004, NRC 2006, Crouse-Quinn 2008, NRC 2015a, Sugden 2016)

TABLE 2. Ideal Communication End-States for Disaster-Resilient Communities Identified in Current Research

End-State	Recommending Research
Clear pathways for hazard, risk and emergency information integration and public dissemination exist with the following properties: a. Mechanisms exist for community member concerns and requirements to be transmitted back to emergency response decision makers b. Information dissemination platform choices and technology utilization reflect local socioeconomic conditions and vulnerable community subgroups. c. Continual feedback process exists to allow for updating of emergency managers' hazard communications CONOPS based on changes in local conditions. d. Indicators for measuring the progress and success of information communications systems are developed and monitored during the disaster planning cycle	FEMA 2013, NRC 2015a
Coalitions of community organizations and external partners exist to educate community members (especially vulnerable populations) about hazard risks, emergency services, warning services, and response plans.	FEMA 2012, FEMA 2014
Indicators of individual-, household- and community-level risk comprehension and preparedness behaviors are understood at the community level and are tracked through time.	FEMA 2014
Communities at risk know when a hazardous event is imminent, through an appropriate (i.e. place-based) combination of: a. Top-down communications and information sharing from government agencies, scientific organizations, and/or official hazard warning services b. Horizontal, community-driven communications enabled by local leaders, local organizations, hazard-specific warning systems, social media, etc.	POTUS/NSTC 2005
Modeling techniques are employed to project real-time flood hazard impacts for large and small basins while integrated, area-targeted, multimedia systems issue warnings on flash-floods and other rapid on-set disasters.	POTUS/NSTC 2005

VII.   Ancillary Benefits

Sharing Lessons Learned with the Dam Safety Community

The interviews conducted during this study highlighted the importance of communicating and sharing dam risk information with local officials with a role and responsibility in public safety and emergency management. In the current state of practice, the dam owner is responsible for developing an Emergency Action Plan (EAP). The dam owner's emergency action plans, describes actions to be taken during a dam incident to stabilize an emergency situation at the dam (typically infrastructure focused). EAPs also include a notification list to reach the relevant parties that have a role or responsibility in the emergency response. However, the dam safety community's involvement in pre-emergency planning that supports floodplain management, public awareness, hazard mitigation planning and other community focused mitigation actions have not really been part of the emphasis in dam safety programs.

The dam owner's emergency action plan should inform the State and local emergency operations/response plans and vice versa. The dam owner has a role in managing the risk associated with dam related flood hazards, but other stakeholders have a role and responsibility as well, such as, emergency management authorities, first responders, planners, floodplain managers, and the insurance industry, to name a few.

One of the lesson learned during the Oroville incident is that communications and coordination between the dam owner/operator and local officials can be improved. Risk communication and stakeholder participation should ensure that (1) responsible and affected stakeholders will be partners and be afforded the opportunity to participate in decisions that affect them, and (2) communications regarding potential inundation hazard, consequences, and shared solutions will be open, transparent, and understandable. The dam owner's emergency action plan should inform the local emergency operations/response plans and vice versa. The dam owner has a role in managing the risk associated with dam related flood hazards, but other stakeholders have a role and responsibility as well, such as, emergency management authorities, first responders, planners, floodplain managers, and the insurance industry, to name a few. Dam risk information should be communicated and shared to support a community's efforts in conducting threat and hazard identification and risk assessments (THIRA), developing dam hazard mitigation strategies, emergency preparedness and response planning, and developing recovery plans.

For over 30 years, the federal government has invested in the National Dam Safety Program (NDSP) to support to dam safety community of practice in reducing the risk from dam failure in the United States. The NDSP is a partnership of the states, federal agencies, and the private sector that encourages the establishment and maintenance of effective Federal and State dam safety programs to protect human life, property, and the environment. To build a more comprehensive and effective program in reducing the risks to life and property from dam failure, it is imperative that emergency managers, planners, floodplain managers and emergency responders become involved and inform national policy on dam hazard risk reduction.

There is an opportunity for FEMA to position the National Dam Safety Program to implement a more comprehensive risk management and hazard reduction framework approach that proactively engages potential populations at risk from dam related flood hazards.

VIII.   Case Study Results

Emergency Manager Interview Results

Our experience interviewing critical infrastructure managers, public safety personnel and emergency response decision makers in the Central Valley of California revealed that many of the perennial challenges for communicating risk and warning information for rapid-onset hazards in a complex social system are present in the Oroville Dam inundation zone. The range of socioeconomic, demographic and cultural diversity, settlement distribution, technological preference, political jurisdiction and public-private engagement within the communities downstream of Oroville Dam present difficulties for communicating emergency alerts that maximize protective action while minimizing loss of life and property. Even so, officials at all levels of government in the area identified communication tools, processes and concepts that they felt had (or would have had) the greatest positive impact during the Oroville Spillway evacuation - many of these reflecting common observations and recommendations in the academic literature. The most commonly-identified of these communicative methods are summarized below.

- **Varied Usage of Social Media and Telecommunications Technology:** Oroville-area emergency managers noted that simultaneous usage of multiple social media platforms and telecommunications channels to deliver evacuation warnings and emergency updates was key to reaching the broadest community audience possible. Further, intelligent deployment of messaging platforms, taking into account the strengths and weaknesses of each, was seen as highly beneficial. Exploiting the low bandwidth nature of text messages in tandem with the high throughput nature of social media was a prominent example cited by officials. A detailed listing of the pros and cons associated with communication tools used during the Oroville spillway evacuation is included in Appendix A.

- **Inter-Agency Sharing of Emergency Communication Resources:** Existing agreements for the sharing of facilities and equipment allowed some Oroville-area emergency management agencies to quickly transition their public communications operations in response to common disaster contingencies, such as mandatory office evacuations and telecommunications service disruptions. These plans and agreements established key functional redundancies that ensure the survivability of emergency communications activities throughout the initial emergency response stage.

- **Establishing Credibility via a Community 'Trust Agent':** Like many communities, the diversity of sociopolitical views and personal experiences of Oroville-area residents are such that local emergency managers recognize that personalization of government-originated protective action orders may not be automatic. In fact, as evidenced by the results of our community survey, a large number of Oroville-area residents did not heed the evacuation warning. Local emergency managers are well aware of this, and the primary way these managers establish credibility and buy-in with the public was through coordination of messaging with the most trusted and authoritative local figure – in this case, Butte County Sherriff Kory Honea. Some emergency managers found that simply sharing or retweeting messages posted by Sherriff Honea's office was the easiest and most effective way to establish credibility with the community.

- **Delivering Warnings to Vulnerable and Special-Needs Populations:** The process of understanding who is vulnerable to rapid-onset hazards – a fundamentally local and community-specific activity – requires significant mitigation-stage planning activities including identifying where vulnerable populations live and inventorying their emergency communication needs. Oroville-area emergency managers found that their strategic planning activities in this area paid dividends during the spillway evacuation, particularly because they were able to quickly share location and needs information with public safety personnel. This enabled police and fire departments to efficiently conduct direct emergency communication and accountability operations for vulnerable members of the

community. Just as public trust affects community members willingness to heed emergency warnings, it also affects the willingness of vulnerable community members to share information about themselves to government agencies. Emergency managers found that their participation in community engagement activities (including formal information sessions as well as presence at festivals, fairs and other events) created public trust and buy-in for these efforts.

- **Combatting Rumor and False Information:** All Oroville-area emergency management personnel noted a large amount of incorrect information about both the state of Oroville Dam and the evacuation proliferated on social media during the spillway crisis. Personnel who attempted to directly respond to and mitigate false information on a case-by-case basis discovered that this task can quickly become overwhelming – especially for smaller emergency management agencies with limited resources. However, several of these agencies found that the following strategies helped to combat the effects of rumor and false information on social media:
    - Preempting false information by quickly posting official messages during the onset of the emergency;
    - Establishing credibility by posting, sharing or retweeting the communications of the recognized local 'trust agent'
    - Being consistent in official messaging

- **Utilizing Local Media Partnerships:** Existing partnerships with local traditional media outlets (TV, radio, websites, etc.) were noted as beneficial for the coordination and quick release of public messaging in different platforms. Oroville-area emergency managers recommended that all government jurisdictions should cultivate strategic relationships with traditional media outlets to enable official messages to be released quickly during emergencies.

Photo Source: Butte County Sheriff (Feb. 2017) Oroville Spillway Incident Press Conference 2/13/17 @ Noon, Facebook Web.,
https://www.facebook.com/bcsonews/photos/a.145283958955224.34659.119221578228129/781741938642753/?type=3&theater

Butte County Sheriff
February 12 · 🌐

This is an evacuation order.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

A hazardous situation is developing with the Oroville Dam auxiliary spillway. Operation of the auxiliary spillway has lead to severe erosion that could lead to a failure of the structure. Failure of the auxiliary spillway structure will result in an uncontrolled release of flood waters from Lake Oroville.

In response to this developing situation, DWR is increasing water releases to 100,000 cubic feet per second.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

This in NOT A Drill. This in NOT A Drill. This in NOT A Drill.

1.1K Likes   1.5K Comments   14K Shares

Photo Source: Butte County Sheriff (Feb. 2017) Facebook Web., https://www.facebook.com/bcsonews/posts/781255845358029

Yuba County shared Yuba County Office of Emergency Services's post.
February 13 · 🌐

Evacuation orders remain in effect. We will let everyone know if anything changes. Keep watching here.

Yuba County Office of Emergency Services
February 13 · 🌐

This morning, ALL Yuba County communities on the valley floor are still under Mandatory Evacuation, with the exception of Wheatland, which is under Voluntary Evacuation. The Mandatory Evacuation applies to District 10, Marysville, Linda, Olivehurt, Arboga, and Plumas Lake. Please DO NOT return to those areas until we determine it is safe to do so. We are working to keep people out of harm's way. We understand evacuation orders in Sutter County, Yuba City and Live Oak are also unchanged.

Photo Source: Yuba County Office of Emergency Services (Feb. 2017) Facebook Web.,
https://www.facebook.com/YubaCounty/posts/1344275862303136

Photo Source: State Emergency Operations Center (Streamed Live, Feb 12, 2017) Cal OES, Web., https://www.youtube.com/watch?v=CJVG0z1g6Eo

Photo Source: *Governor Brown Speaks from the State Operations Center for Oroville Spillway Response and Recovery* (Feb. 13, 2017) Cal OES, Web., https://www.youtube.com/watch?v=xt4hYFaBN9s

IX. Conclusions

We recognize that the study focused on one small aspect of the entire five stages noted in our National Preparedness Goal captured in PDDD8 - "*A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to and recover from the threats and hazards that pose the greatest risk,*" but it underlines the thesis that effective communications contributes to the potential resiliency of the community. We hope it is helpful.

Key Trends in Messaging, Audiences, and Communities

Overall, the team identified several key trends related to messaging, audiences, and communities in its examination of emergency communications, both in theory and in practice. Generally speaking, individuals are more inclined to believe emergency communications that are delivered consistently across multiple platforms and repetitively from sources they find credible. If these criteria are met, they will be more likely to take the appropriate protective actions. Individuals are also more likely to be receptive to messaging that is more specific, comes from local sources, and is empathetic, reassuring, and stress-reducing. The messaging is more useful when it is accompanied by visual maps displaying the locations of the potentially affected areas. Another key finding is the importance of tailoring messaging for specific audiences in the community – attempts at one-size fits all approaches are generally less effective.

Audiences tend to be receptive to emergency communications if they themselves have an existing strong social network, if they have had previous experience with a hazard, and are more knowledgeable about the protective actions authorities are recommending. Previous "false alarms" also don't seem to make individuals less receptive to future messaging, indicating that emergency managers can perhaps err on the side being proactive in reaching out to the public.

Different factors in the community itself also affect the efficacy of emergency communications. For example, clear existing pathways for communication – both community-driven and top-down from emergency response decision-makers – can increase the effectiveness of messaging. Ideally, methods for dissemination should also reflect what is accessible to the population of each individual community, including those living under a variety socioeconomic conditions and those with disabilities or others with access and functional needs; how information is shared should reflect how community members are able to actually access that information. Communities are also generally more effective in sharing emergency communications when they have the means to measure the progress and success of communications and to understand indicators of preparedness behaviors and risk comprehension at the local level and track that over time. Emergency communications are also more effective when there are coalitions of organizations present to educate community members, and when communities use modeling to project disaster impacts and use those to inform more targeted alerts and warnings.

Comparison of Different Messaging Mediums

Over the course of several months, the AEP research team considered a variety of practices for evacuation messaging and the effectiveness of each, both in general and as observed during the Oroville, CA dam incident specifically. The intent of this work was to catalogue the relative strengths and weaknesses of each approach, as well as to document lessons learned and best practices from the Oroville case study. The AEP team ultimately explored the potential capabilities and limitations of blogging, character-limited social media, direct verbal contact, email, radio broadcasts, robo-calls, sirens, television broadcasts, and text messages.

Several of these mediums, including blogging and character-limited social media, have similar advantages and disadvantages. For example, both of these can make information available to the public for free or at low cost and are able to reach large audiences. They're also multi-media platforms, able to share information via text, videos, and photos, and the messaging itself can be tailored to reach a wide variety of populations. Both are also useful as

relatively quick and easy platforms for alerts and warnings. On the other hand, while individuals identify and self-select the sources they find most trustworthy, it can ultimately be challenging to verify whether a source's credentials are valid and to differentiate facts from rumors. There are also some differences amongst these mediums. For example, while there are character limits for some social media platforms (compared to blog posts, which can be lengthier), character limited social media posts can often be composed and distributed more quickly when a disaster is imminent or ongoing.

On the other end of the spectrum is direct verbal contact, actually going door to door and alerting individuals in person. There is a higher level of effort associated with this as individuals need to physically go into communities and speak with residents. There can be cost to this as well if the individuals reaching out to community members are being paid for their services. The size of the audience reached can be also be limited by the number of personnel and volunteers available and the level of effort involved, the quality of the messaging can vary considerably, depending on the individuals delivering it. It can also be more challenging to reach some vulnerable populations. On the other hand, individuals tend to take messaging more seriously and are more inclined to trust it when it is provided to them personally. It can also be easier for a centralized local authority to ensure the information being provided is accurate if it's directing its own personnel or volunteers to deliver the message.

Lessons Learned and Recommendations

In its review of different emergency communication messaging mediums, the AEP team documented several recommendations, best practices, and lessons learned. Three overarching trends emerged from the AEP's work. In order for emergency communications to be effective, communities must 1) Work together and coordinate messaging, involving private, public, and non-profit stakeholders and those at all levels of government; 2) Ensure that messaging is accessible to all residents, especially vulnerable populations; and 3) Pursue forms of communication like text messaging that can convey actionable, reliable information to large numbers of residents quickly at low-to-no cost, although communities should ultimately pursue what works best for their specific population's needs. Following these recommendations can help communities to save lives and property, and help communities recovery from disasters more quickly, enhancing their overall resilience.

Bringing Communities Together: Government agencies need to collaborate and coordinate with each other and with media outlets to make sure communication presented on television and radio broadcasts and other mediums, including government websites, is timely, accurate, consistent, and concise.

Accessible Communications: It's also important that governments work with radio and television stations to ensure their broadcasts are accessible to community members that speak foreign languages, individuals with disabilities or other access and functional needs, and other vulnerable populations. Local authorities must also test sirens and other alerts and warning systems periodically to make sure they are working as intended.

Overall Effectiveness: Text messages proved to be the best overall method for communicating with local residents. Compared to other approaches, text messaging combines ease of use, low cost, and effectiveness. However, text messages must be accessible to all members of the community including vulnerable populations. And means for improving the delivery time of these messages should be explored.

Some mediums, such as emails and radio announcements, are helpful in a supplemental capacity, but ultimately not as effective as text messaging. Others, such as direct verbal contact and sirens, can be very effective in different ways, but are more resource and labor intensive. Robo-calls proved to be less effective in general because they were unclear and ultimately confused some local residents.

The team also found that social media has an important role in emergency communications, especially during active incidents. However, while this is a quick and accessible form of communication, it can be challenging to verify the

credibility of information presented this way. Third-party verification that social media content is accurate, up-to-date, and credible is especially important for character-limited formats. Government websites play an important role in dispelling rumors and other inaccurate information before, during, and after emergencies. Communities may also want to explore leveraging television stations as a means of countering inaccurate information; television stations play a vital role in informing community members, remain a trusted source of information among residents.

X.   Appendix A – Inventory of Communications Tools

The following provides a high-level inventory of various tools used to communicate with residents and other stakeholders possibly impacted by a failure of the Oroville Dam Emergency Spillway in February 2017.

The Team's qualitative assessments were built based on interviews, literature reviews, and survey results. While there were 2,095 individual responses to the surveys sent by the Butte, Sutter and Yuba counties to local residents, the qualitative assessments remain subjective in nature, as the sample size was statistically valid, but the questions posed did not align exactly to the tools assessment.

In each of the following tables, we provide a high-level description of the communication tool, including technical, financial, and resource requirements and limitations.

Based on interviews and research, the AEP team compiled some of the perceived limitations (cons) and some of the potential strengths (pros) of the communications tools.

The qualitative assessment below represents the best estimates and input of the team based on the data and feedback received.

- **Definition:** Forms of electronic communication (such as websites) through which people participate in online communities to share information, ideas, personal messages, etc..[10]
- **Participation:** Individuals generally must opt into or follow specific individuals, groups or outlets of interest. Online communities develop their own rules as to whether new individuals can join or must be invited.
- **Amount of Information:** Participants "post" entries on topics of interest and are able to share as much or little information as desired. However, additional information can usually be gleaned from users' profiles, unless strict privacy settings are in place.
- **Common Non-Character Limiting Platforms:** The most universally used social media include Facebook, Instagram, Pinterest, and LinkedIn. Additionally, platforms such as Google + and Digg have established communities. Most of these do not have character limits, however, they may be limiting in other ways.
  - Facebook is the largest social media platform and an estimated 829 million people use Facebook on a daily basis.
  - LinkedIn is a business- and employment-oriented social networking service. While widely used, few individuals check LinkedIn as often as they check Facebook.
  - Digg is a news aggregator with a curated front page, aiming to select stories for the Internet audience such as science, trending political issues and viral Internet issues. Digg reaches a smaller niche community. A significant percent of its traffic comes from Facebook and Google.
  - Pinterest allow users to visually share and discover new interests by posting or sharing images or videos. This platform lends itself more to the dissemination of visuals.

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[10] "Social Media." Merriam-Webster, Merriam-Webster, Web. 31-JUL-2017, www.merriam-webster.com/dictionary/social%20media.

Capabilities (pros):	• **Cost of entry:** Participants download free or low-cost communication apps or programs to computers or smart devices. • **Audience size:** Audience is geographically widespread and can include anyone expressing interest in a community's topic. • **Messaging:** Messages are not character limited and can include text, photos, videos, links, etc. • **Trustiness:** Communities self-select and often place trust in those providing information. • **Effectiveness:** Easy to use for both alerting and warning, can instantly reach a large target audience, additional authenticity provided with individuals within a community share, react, or comment • **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	• **Self-policing:** Differing levels of security and processes to verify whether individual's self-proclaimed credentials are valid. • **Validation:** Hard to differentiate facts vs. rumors as anyone can provide information. • **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, elderly).
Selected feedback from survey responses	• In answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, **31.45% used non-character limited social media platforms** and **3.17% used character limited social media.** o Additionally, comments provided in our survey resulted in 39 responses that included references to social media (Facebook, LinkedIn, Pinterest, etc.). About 64% respondents reported using Facebook for alerts. Some of the following comments are included below this table.
Lessons learned and recommendations	• Text messages and social media plays an important to communicate with the residents. • Sheriff's department, local government agencies, and California government agencies (Department of Water Resources) need to make sure

	communication is timely, accurate, and concise. Seek to have the information to be consistent.
	● Use all government resources and make sure there is coordination and collaboration with all local government agencies.
	● Social media has an important role in communications to the public especially during emergencies. On a positive note, social media disseminations can be very quick and can be communicated by anyone who has a social media account to share with the rest of the world. However, social media posts by individuals sometimes do not substantial information verification by third party credible sources to make sure the information is accurate and up-to-date.

Survey Quotes Related to Non-Character Limited Social Media Platforms

- *"I was not enrolled in an emergency alert system until after the evacuation. I received information through friends reaching out to me and by looking at posts on Facebook."*
- *"It was interesting that Facebook had the most up to date info. . . . TV info was lame and often inaccurate. Emergency notification system worked well."*
- *"There was a lot of confusion between news reports and local office of emergency services on which counties were evacuated and how long the mandatory evacuations were in effect. I took to the Facebook page for our office of emergency services for accurate information and didn't listen to local news stations."*
- *"I don't want to get information from Facebook, it doesn't seem official and would prefer one source to go to get information."*
- *"I saw a news article on Facebook from Butte County, and we left within 45 minutes. 2 hours after I saw the news article and we [were] already long gone from town is when I received the text and phone call saying there was an emergency evacuation. That is unacceptable."*
- *"Yuba County OES Facebook page was the bright spot during the whole event. They kept us informed and did not panic."*

Character-Limited Social Media	
Description:	● **Definition:** Social media that limits the number of words or characters. Characters-limited social media platforms were designed to be used with phones, mostly with SMS, which would start to split messages at 140 characters. ● **Participation:** Individuals generally opt into specific communities of interest. Communities develop their own rules into whether or not to let new individuals join the communities. ● **Amount of Information:** Participants "post" entries on topics of interest but are limited in the amount of characters, spacing included, to the posts. Recently, some of the more common character-limited social media (e.g., Twitter) are expanding to allow more characters and to include posting of photos, videos, etc. Some don't allow any characters (e.g., Flickr, a photo-sharing and hosting service or Vimeo, a video-sharing website). ● **Common Platforms:** The most common character-limited social media include Vimeo, Twitter, Flickr, and Instagram.
Capabilities (pros):	● **Timing:** Provides quick, *in the moment*, interactions. ● **Cost of entry:** Participants download free or low-cost communication apps or programs to computers or smart devices. ● **Audience size:** Audience as geographically widespread and can include as many as those expressing interest in community's topic. ● **Messaging:** Messages are character limited but increasingly can include text, photos, videos, etc. ● **Trustiness:** Communities self-select and often place trust in those providing information. ● **Effectiveness:** Easy and quick platforms for both alerting and warning. ● **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	● **Character limits:** Limits the amount of information that can be conveyed; more likely to be used for alerting to an event, less likely to provide detailed recommendations on how to address risk. ● **Self-policing:** Differing levels of security and processes to verify whether individual's self-proclaimed credentials are valid.

	• **Validation:** Hard to differentiate facts vs. rumors as anyone can provide information. • **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	• As noted above, in answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, 31.45% used broad social media and 3.17% used character limited social media like Twitter. Additionally, the comments provided during the survey also resulted in 39 responses that included references to social media, and 10.26% of those respondents used Twitter for alerts. Some of the following comments are included below this table.
Lessons learned and recommendations	• Social media has an important role in communications to the public especially during emergencies. On a positive note, social media disseminations can be very quick and can be communicated by anyone who has a social media account to share with the rest of the world. However, social media posts by individuals sometimes do not substantial information verification by third party credible sources to make sure the information is accurate and up-to-date. • For character-limited social media, the need for credible third-party verification is especially important to make sure the social media content is accurate, up-to-date, and credible.

Survey Responses Related to Character-Limited Social Media
- *"Our family did not hear about the evacuation from the emergency system first. Both a text from a friend who noticed it on Twitter and local TV broadcasts reached us first. . ."*
- *"Surprisingly, Twitter was the best source of official information. Based on that I established an account for the governmental organization I manage."*
- *"We were watching a local broadcast TV channel and it was a disappointingly long time before any notification was given. It came in the form of a scrolling message without any audio message. We simultaneously turned on the radio to KFBK, a news/talk station and The Car Show was merrily playing without any mention of the evacuation notice for quite some time. Thankfully our son received a Twitter message from someone who notified us."*

Direct, Verbal Contact
(Door knocking, patrol car announcements, etc.)

Description:	**Definition:** Direct verbal communication with residents to share emergency announcements. **Participation:** County officials and sheriff deputies were involved in the door knocking and patrol car announcements to evacuate residents. **Amount of Information:** County officials and sheriff deputies shared to the residents that they had to evacuate due to the potential flooding from the Oroville dam.
Capabilities (pros):	**Cost of entry:** Requires individuals to reach out and to communicate to the residents. **Audience size:** Limited outreach because it would take many efforts for the county officials and sheriff deputies to reach many residents. **Messaging:** Depends on effectiveness and hearing of messages. **Trustiness:** People tend to take it more seriously since someone is trying to reach them. **Effectiveness:** It is labor intensive and takes many efforts to reach as much residents as possible, especially the elderly, youth, homeless, people with disabilities, and other vulnerable populations. **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	**Self-policing:** Often messaging directed by local authorities (e.g., police departments…). **Validation:** Centralized messaging pointing to other resources. **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	Direct, physical contact by an official (e.g., door knocking, patrol car Public Address system) represented 3.03% of the responses to the type of communication notification received or viewed. Comments provided during the survey provided a handful of responses that included references to this. The comments are provided below this table.
Lessons learned and recommendations	Direct verbal contacts with resident during emergencies are effective, but the efforts can be very intensive and would take much financial resources to hire and pay county officials and sheriff deputies to talk with as many residents as possible to evacuate.

Survey Quotes Related to Verbal Contact

- *"I had only resided in Butte County for thirty days when the evacuation occurred. Total confusion. I was terrified for my daughter and I (as well as for my pets). Just one-day prior we were at the lake admiring its beauty. I did get a text, in which I ignored. I didn't think it pertained to me. Then I received a phone call from a distant friend. Again, I was confused and didn't know if the evacuation included the vicinity in which I live. Then I turned on the TV. I remember the broadcast saying the evacuation included South Oroville. I was very new to the area and again wasn't clear if the evacuation included where I reside. . . . . not until I received a phone call from my very new supervisor did I think my family and I were in any kind of real threat. Hands down, I owe it to my supervisor! Ten minutes after speaking with him, I received a knock at the front door from a Sheriff. We then left immediately taking nothing but our two cats (unfortunately leaving one behind, he hid from all the commotion). It was truly a very traumatic experience!"*
- *"In person announcements or loudspeakers in the streets may have helped".*

Emails	
Description:	● **Definition:** A system for sending written messages directly to recipients via the Internet. Messages can be personally sent or sent to mass distribution lists. ● **Participation:** Anyone can receive an email as long as the individual has Internet and an email account and can read in the language the message is sent. ● **Amount of Information:** Can be as short and broad or as detailed and specific as needed, depending on the government authorities. ● **Common Platforms:** Internet providers such as telecommunication companies provide the technology infrastructure for residents to receive emails from the government.
Capabilities (pros):	● **Cost of entry:** Free. Recipients only need to pay for Internet either in their homes or on their smartphones. Most people use free email servers such as Gmail, yahoo, or Hotmail. ● **Audience size:** An estimated 98 percent of individuals in the United States have an email account. However, not everyone accesses their account on a regular basis - particularly in immigrant and low-income communities. According to Pew Research Center, nine in 10 Americans are online. ● **Messaging:** Most email recipients will not read anything more than three paragraphs long. Make sure email is drafted in the inverted pyramid style so that recipients consume the most important information. ● **Trustiness:** As it is arriving to their personal email, recipients are likely to be receptive and trust the source of the information. ● **Effectiveness: Easily sent to a mass group of recipients and communications appear immediately in their inbox.** ● **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	● **Delay in Reading and Response**: Studies find that it takes email recipients on average 16 minutes to read an email during working hours and that after working hours, recipients are less likely to read email. In the instance of an emergency, email is likely to be effective only for those individuals who receive email notifications on their

	smartphones. Information may be old by the time recipients read their emails. It is difficult to send continuous updates. ● **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	● As noted above, in answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, **6.84% used Email.**
Lessons learned and recommendations	● While emails work to communicate with community residents during emergencies, emails, by themselves, are not enough to communicate with community members during emergencies. Text messaging and social media were far more effective than email in the Oroville Dam spillway incident. ● Emails, along with texting, will increase the percentage of community residents to receive information to make sound decisions during emergencies.

Radio Broadcasts	
Description:	**Definition:** The transmission and reception of radio frequencies. **Participation:** Anyone can hear the radio broadcasts if they can receive the radio medium. **Amount of Information:** Can be as broad or specific as determined by the government officials. **Common Access to Platform:** Most people in the United States only listen to the radio in the car.
Capabilities (pros):	**Cost of Entry:** The Emergency Alert System requires radio broadcasters to offer to the President the communications capability to address the American public during a national emergency. The system also may be used by state and local authorities to deliver important emergency information such as AMBER alerts and emergency weather information. **Audience Size:** About 256 million people are estimated to listen to the radio in the United States. Most of these individuals listen only while in the car. Listenership is at its highest during commuting hours **Trustiness:** Trustiness of this platform may vary depending on radio broadcasting outlet. **Effectiveness:** Potentially capable of reaching a large listenership in real-time. **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	**Self-policing:** The radio stations ultimately control accurate and timely dissemination of this information. Radio listeners select which stations they listen to. **Validation:** Most individuals learning about an emergency situation via radio, will cross reference via another station or platform. **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	As noted above, in answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, 14.06% used radio. Additionally, the comments provided during the survey also resulted in 133 responses that included references to radio or TV. Some of the following comments are included below this table:

Lessons learned and recommendations	● The radio announcements were helpful, but not as effective as in texting and social media. Local and state governments need to make sure the information is accurate before sending it to the local radio stations. ● Radio stations need to work with state and local government officials to make sure the information is consistent, so there is no confusion to the residents. ● Radio stations need to be aware of the changing demographics in the community to include Spanish and other ethnic groups' languages in order to help New Americans be aware of emergency situations.

Survey Responses Related to Radio

- *"It felt like there was a disconnect between Butte, Sutter and Yuba counties in communicating information. We were very thankful for Regional TV outlets and local radio for updates and coverage."*
- *"Only had a radio for information. They kept saying evacuation advisory. Never sure if it was mandatory or voluntary evacuation. Could not even get out of my driveway due to traffic."*
- *"During our evacuation drive we tried to find a radio station covering the evacuation but could not find ANY station covering it. Where was the office of Emergency Services when this was all going on?"*
- *"There were no Emergency Broadcast System messages over the radio or TV. Funny I hear the tests all the time, but during the evacuation, every station kept playing music and commercials like nothing was happening. Only one AM station had nonstop coverage of Oroville Dam Evacuation news and instructions. We were glued to that AM station all night in bumper to bumper traffic, terrified with crying children and frightened grandparents."*

Robo-calls / Reverse 911

Description:	 ● **Definition:** An automated telephone call that delivers a recorded audio message. ● **Participation:** Capable of reaching broad masses with phone numbers belonging to the targeted area code. However, many communities include transient individuals with phone numbers beginning with area code outside of the targeted area. Most recipients do not listen to the audio message in its entirety. ● **Amount of Information:** While there is no limit to the amount of information that can be communicated via robo-calls, there is a limit to the amount recipients will retain.
Capabilities (pros):	● **Cost of entry:** The cost of a phone bank to handle the robo-calls. ● **Audience size:** Robo-calls can reach the phones of a broad target group, however, many recipients will elect not to answer a phone call from a number they do not recognize. If the call goes to voicemail there may be a delay in the time that they listen to the voicemail. ● **Trustiness:** Most recipients do not trust information received via a robo-call due to the increase in spam calls. ● **Effectiveness:** Most recipients report feeling annoyed by robo-calls. ● **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	● **Validation:** Recipients will likely cross-check information calls to validate information. ● **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	● As noted above, in answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, 22.85% received phone call (e.g., robo-call, mass).
Lessons learned and recommendations	● Robo-calls were not effective because they were not clear and the information caused confusion to some local residents. Residents were asking what the Robo-calls were about, and the residents did not know the source of the Robo-calls.

Sirens	
Description:	● **Definition:** Loud noise used to provide emergency population warning of danger or signal that danger has passed. ● **Participation:** The sirens will reach everyone in the community, however may exclude the hearing impaired. ● **Amount of Information:** Little to no information transmitted and may be confusing for some residents that may not know how to respond.
Capabilities (pros):	● **Audience size:** Anyone within hearing distance. ● **Messaging:** There is little messaging conveying by a siren, as the messaging relies heavily on residents knowing what the sound of the siren means and how to respond. ● **Trustiness:** There is little reason for community residents to not trust a siren alarm and residents will not doubt the source of the information or seriousness of the warning. ● **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	● **Validation:** While residents will not need to validate the source of the information, the lack of detailed information conveyed may leave residents validating the appropriate response via other mediums. ● **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	● As noted above, in answer to the survey question in which respondents were requested to provide the type of notification received or viewed about the evacuation during the Oroville Dam spillway incident, only 1.32% noted warning siren in the responses.
Lessons learned and recommendations	● Sirens were very effective in the past. Given the need to update the technologies on sirens, federal and state governments need to give resources to the local authorities to update the sirens, so they can inform the residents about the emergencies. ● Local authorities need to test the sirens periodically to make sure the sirens are working as intended.

Survey Responses Related to Sirens
- *"Sirens would be nice. We're still small enough to hear them."*
- *"Wish there was a siren horn in Gridley."*
- *"In person announcements or loudspeakers in the streets may have helped."*

- *"The emergency broadcast never went off, there was no siren if something were to really happen I hope they fix those things, and don't close escape routes."*

Television Broadcasts

Description:		- **Definition:** A program that is transmitted over airwaves for public reception by anyone with a receiver turned to the right channel. - Participation: Anyone with access to television and cable. Along with the growth in online streaming platforms such as Netflix, more and more Americans are opting to not have a TV in their home, therefore the effectiveness of television broadcasts is dimensioning. - Amount of Information: Information can be communicated visually and verbally.
Capabilities (pros):		- **Cost of entry:** The Emergency Alert System requires television broadcasters to offer to the President the communications capability to address the American public during a national emergency. The system also may be used by state and local authorities to deliver important emergency information such as AMBER alerts and emergency weather information. - **Audience size:** Potential audience size actually decreasing as more people opt to forgo the television in favor of online streaming services. - **Messaging:** One risk regarding the messaging of emergency communications disseminated by the broadcast media is that it is up to the network to make sure the information is relayed accurately and in a way that does not confuse the recipient. - **Effectiveness:** This form of communication is dependent on individuals having their TVs turned on at the time the information is broadcast. The effectiveness of this medium can vary greatly depending on the time of day. - **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)		- **Validation:** Most people will change the station to compare coverage to that on other networks. - **Flexibility:** May be difficult to tailor to some populations (e.g., visually impaired, low-income, elderly, young people).
Selected feedback from survey responses		- Close to 40 percent of survey respondents cited turning to broadcast media for information in the instance of the Oroville Dam Spillway.

Lessons learned and recommendations	• Similar to radio broadcasts, state and local governments need to coordinate with each other to make sure the information coming out from the TV stations are accurate and up-to-date. • TV stations play a vital role to inform the community members because the TV stations still have a source of trust with the community members. • TV stations need to make sure the emergency communications and notifications are sensitive to immigrants' needs (e.g., languages and cultures) and other vulnerable populations such as elders, homeless residents, and people with disabilities.

Survey Responses Related to Broadcast Media

- *"The TV broadcast was good, but it was not closed-captioned and my brother-in-law is hard of hearing and didn't understand exactly what was going on. The newscaster also was a bit confused because the notice just said to leave, it was a little vague in the beginning."*
- *"The TV broadcasts (Action News Now) took some time to come on and were only on for maybe 30 minutes. Should have remained on for the entire process to provide updates."*
- *"We like many others, did not get an official notice. Found out 30 mins after it was broadcast on TV from a neighbor. And we were signed up for our land line."*
- *"I think there should have been an emergency alert on the television. My TV is usually on kids channels and we don't watch the news often."*
- *"I found out from a friend that posted something on Facebook. I was surprised there wasn't an emergency notification on TV."*
- *"TV was inconsistent on what to do . . ."*
- *"I was surprised that there weren't any announcements on local TV from the EBS."*

Text messages	
Description:	• **Definition:** An electronic communication sent and received by mobile phone. • **Participation:** While most Americans own a cellphone that can receive text messaging, some vulnerable populations, such as the elderly, visually impaired, and some immigrant communities may not receive and promptly read text alerts. • **Amount of Information:** The maximum number of characters that can be included in a text message is 918.
Capabilities (pros):	• Cost of entry: Recipients are responsible for the cost of their phones and phone service. The government will cover the cost of the SMS service. • **Audience size:** Over 95% of people within the Unites States are reported to have a cellphone. Almost 90 percent of those individuals own a smartphone. • **Messaging:** The government will have control over the messaging. While there is no limit per say on information that can be communicates via text, entities should avoid sending too many texts. Additionally, they should seek to keep messages short and include the most important information in the first sentence. • **Trustiness:** Recipients tend to trust text communications sent directly their phone. • **Effectiveness:** Studies show that 90% of all texts are read within 3 minutes of delivery. • **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	• **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	About 48.7 percent of survey respondents reported receiving text messages in the Oroville Dam Spillway Incident. Responses pertaining to text messaging are provided below.
Lessons learned and recommendations	• Text messages were the most effective in communicating with the local residents. • Need to make sure the text messages are translated into different languages for New Americans in the community, so all residents can understand the emergencies in their community. Other vulnerable populations such as the elderly, homeless residents, and people with disabilities need to have access to texting or have accessible texting technologies.

	● Need to improve the delivery of text messages to make them communicated faster, if possible.

Survey Responses Regarding Text Messaging

- *"The media and Emergency text messages were not in sync. It was not always clear who should be evacuating."*
- *"I've since signed up for emergency alerts via text message. Texting is good. Using the emergency broadcasting networks might not be the worst idea...telling people in what direction they should be fleeing for their lives might be helpful too."*
- *"The text message I received only said a flood was eminent. At the time Shasta dam was near capacity. I had no idea where a flood was to happen. A friend called and asked if I was getting out. A more informative text would have been helpful."*
- *"Text message system needs to be in real time. The text message went out after 7pm. We only [knew] of the notice to evac because we happened to be in the car and heard it on the radio. Had we not been, we could not have received official notification for almost 3 hours - long after the spillway was expected to fail."*

| Websites	
Description: 	● **Definition:** A location connected to the Internet that maintains one or more pages on the World Wide Web. ● **Participation:** Community Residents will need to actively search out the materials. ● Amount of Information: There is no limit to the amount of information that can be shared, additionally, it can be presented in as many forms as desired.
Capabilities (pros):	● **Cost of entry:** The cost of the domain, cloud storage, and a website to manager. ● **Audience size**: On the World Wide Web this is accessible to anyone with access to the Internet, while in urban areas only 3% of the population lacks access to the Internet, in rural areas that number is greater. ● **Messaging**: Messaging is controlled by the owner of the website. ● **Trustiness:** In emergency situations people tend to trust government-owned platforms as reliable sources of information. ● **Effectiveness:** The website is only effective if there is website traffic. If constituents do not know that the website exists, if the interface is not readable, and if the website is not consistently updated, community members will not go to the website as a source of information. ● **Flexibility:** Communications can be changed to serve multiple different populations (e.g., non-English speakers, hearing impaired).
Limitations (cons)	● **Validation:** Constituents turn to government websites as a source to validate information that they may have found out about first via another platform. ● **Flexibility:** May be difficult to tailor to populations (e.g., visually impaired, low-income, elderly).
Selected feedback from survey responses	● The term and forms of the term "Website" were not specifically mentioned in the "additional comments" section by survey respondents regarding sources of information following the Oroville Dam Spillway, although were included in responses regarding broader online media.
Lessons learned and recommendations	● The state and local governments need to have accurate and up-to-date websites for the community residents to see and to be informed. ● Government websites play an important role to dispel rumors and other inaccurate information before, during, and after emergencies.

XI.   Appendix B – Survey Questions and Responses

The following results were provided by the 2,095 respondents using the SurveyMonkey survey launched by the Butte, Sutter and Yuba Counties in July 2017. It is important to note that during the first week of the survey period, some residents in Butte County evacuated their homes due to wildfires in the county.

Results from the open-ended Question 12, which asked respondents to freely comment on their experiences evacuating in February 2017, are available upon request to **nick.shufro@fema.dhs.gov**. The results will be redacted with personal identification information, medical information and coarse language removed.

Q1: What county do you live in? (Please choose one)

▶ Answered: 2,095 Skipped: 0
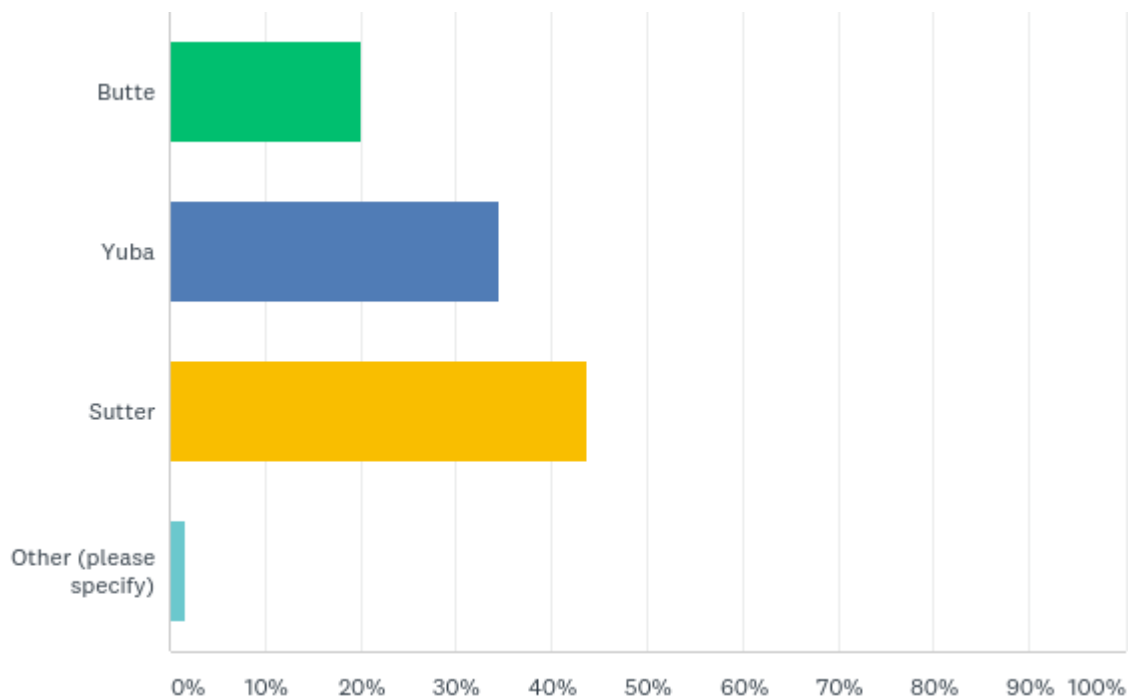
Answer Choices	Responses	
Butte	20.14%	422
Yuba	34.51%	723
Sutter	43.63%	914
Other (please specify)	1.72%	36
Total		2,095

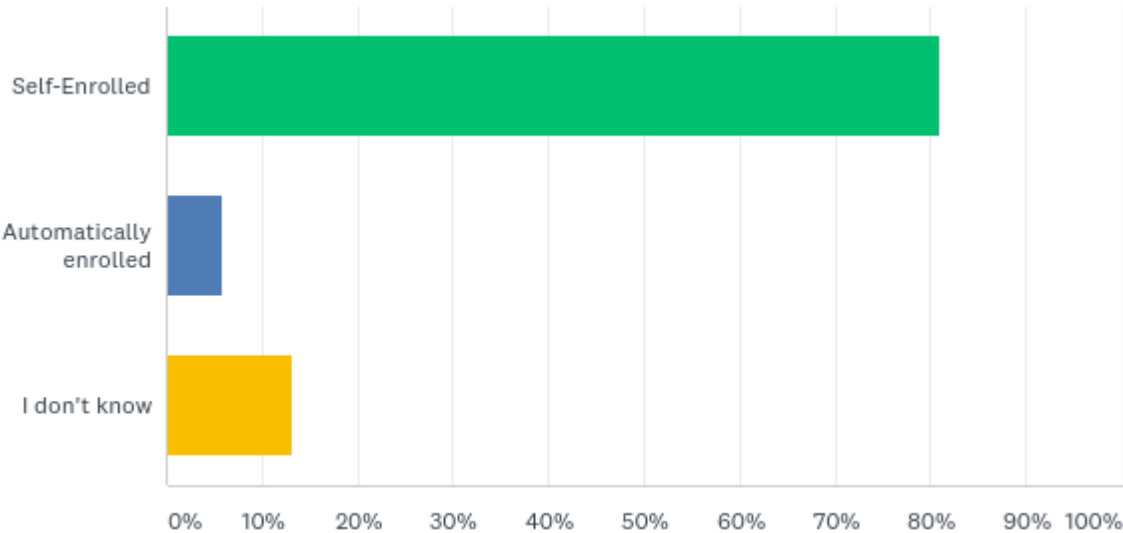Q2: Are you enrolled in a local Emergency Mass Notification System?

▶ Answered: 2,078 Skipped: 17
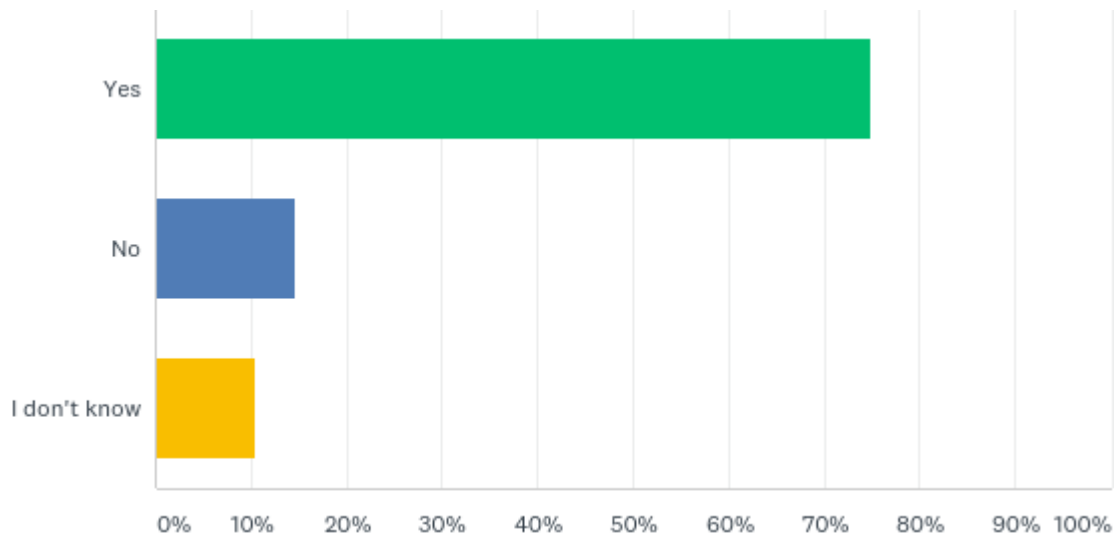
Answer Choices	Responses	
Yes	**74.98%**	1,558
No	**14.58%**	303
I don't know	**10.44%**	217
Total		2,078

Q3: Did you enroll or were you automatically enrolled in an opt-out system for emergency notifications?

▶ Answered: 1,562 Skipped: 533

Answer Choices	Responses	
Self-Enrolled	80.86%	1,263
Automatically enrolled	5.89%	92
I don't know	13.25%	207
Total		1,562

Q4: What type(s) of notification about the evacuation did you receive or view during the Oroville Dam spillway incident (select all that apply)?
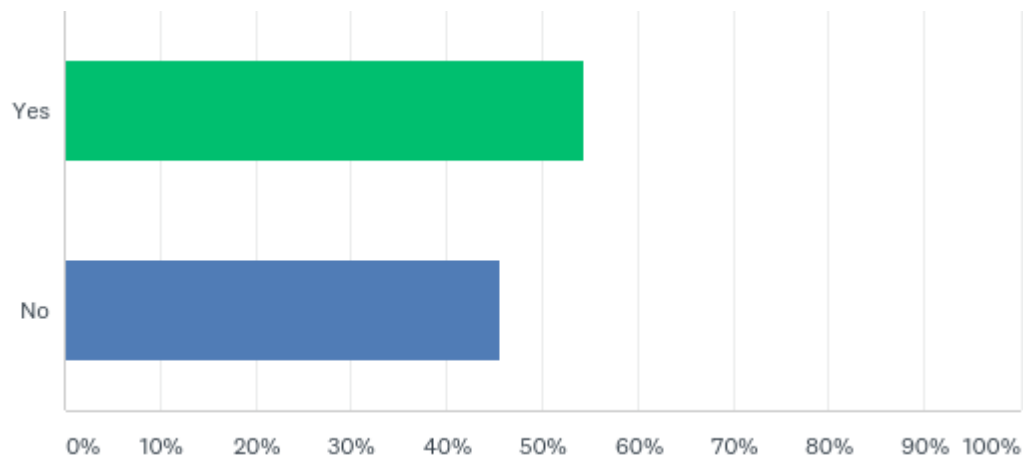
▶ Answered: 2,048 Skipped: 47
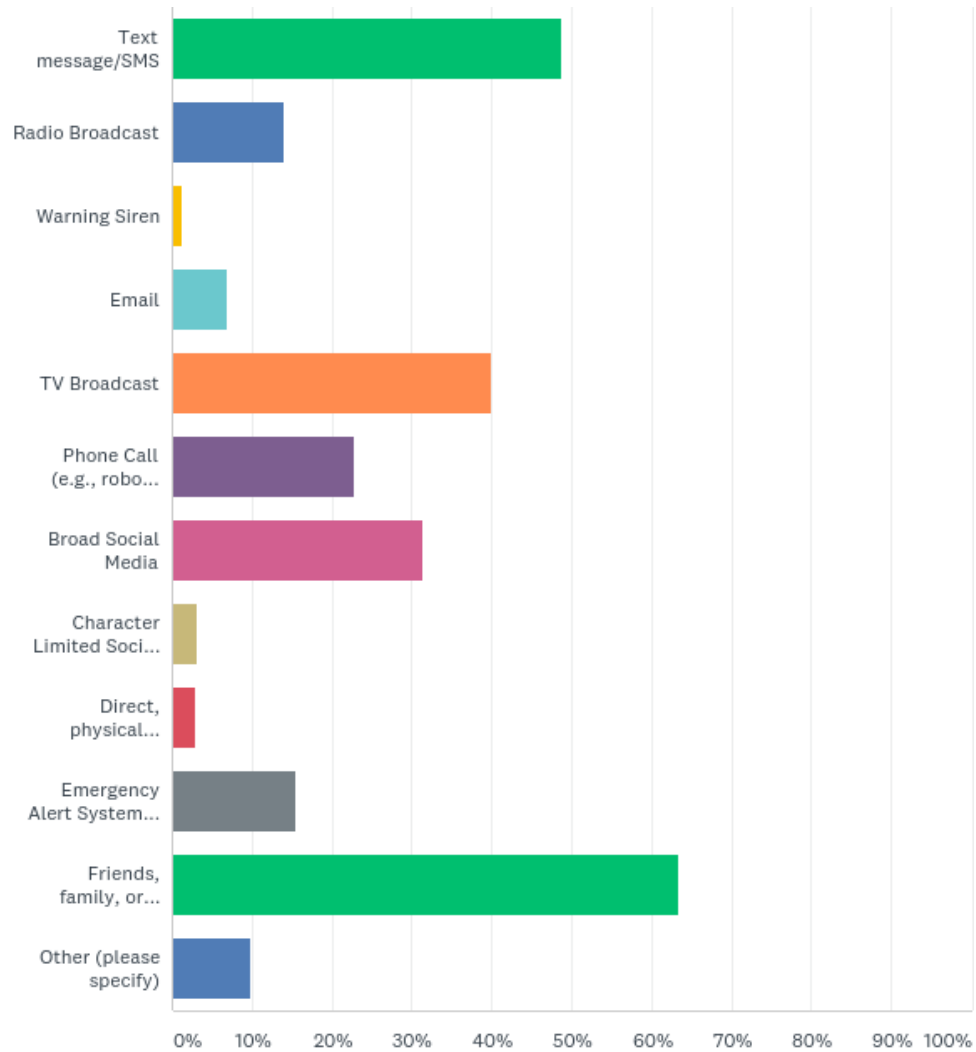
Answer Choices	Responses	
Text message/SMS	**48.73%**	998
Radio Broadcast	**14.06%**	288
Warning Siren	**1.32%**	27
Email	**6.84%**	140
TV Broadcast	**39.99%**	819
Phone Call (e.g., robo call, mass)	**22.85%**	468
Broad Social Media	**31.45%**	644
Character Limited Social Media	**3.17%**	65
Direct, physical conctact by an official (e.g., door knocking, patrol car Public Address system)	**3.03%**	62
Emergency Alert System (EAS) broadcast	**15.53%**	318
Friends, family, or other personal contacts	**63.38%**	1,298
Other (please specify)	**9.77%**	200
Total Respondents: 2,048		

Q5: Was the information in the official evacuation messages clear, timely, understandable, and actionable? (Please choose one answer and/or provide comment).
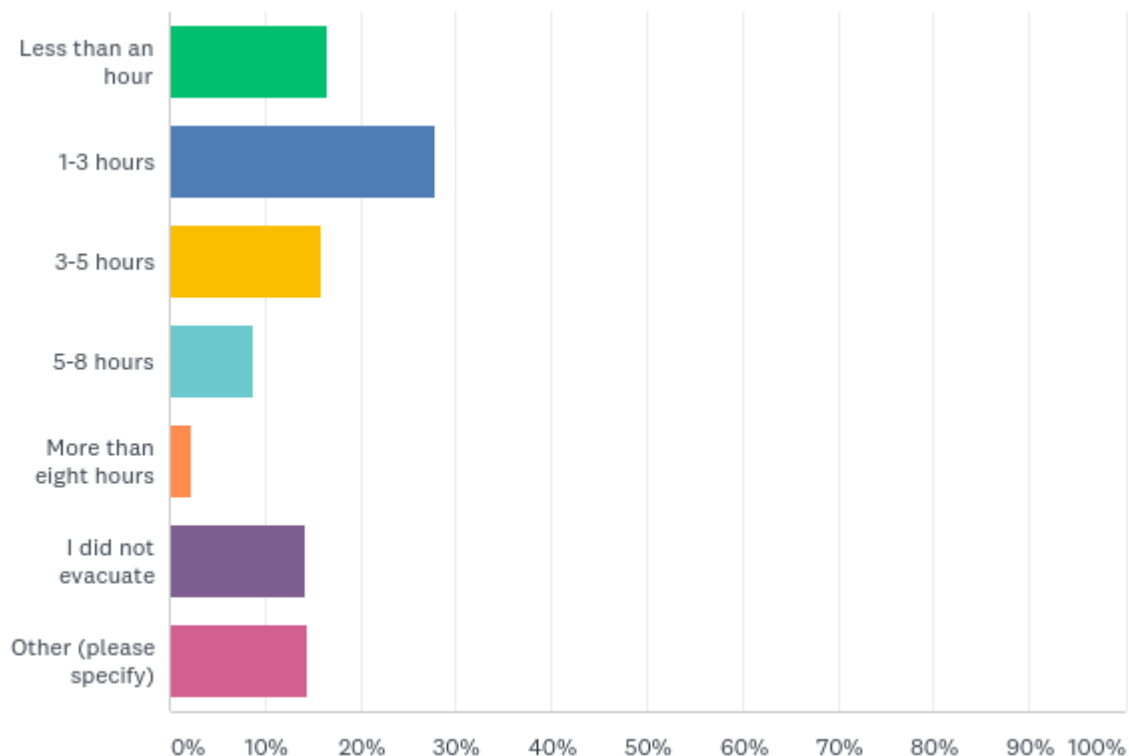
▶ Answered: 2,026 Skipped: 69

Answer Choices	Responses	
Yes	54.34%	1,101
No	45.66%	925
Total		2,026

Q6: How long after you received the first official evacuation notification until you were able to evacuate to a safe zone? (Please choose one)
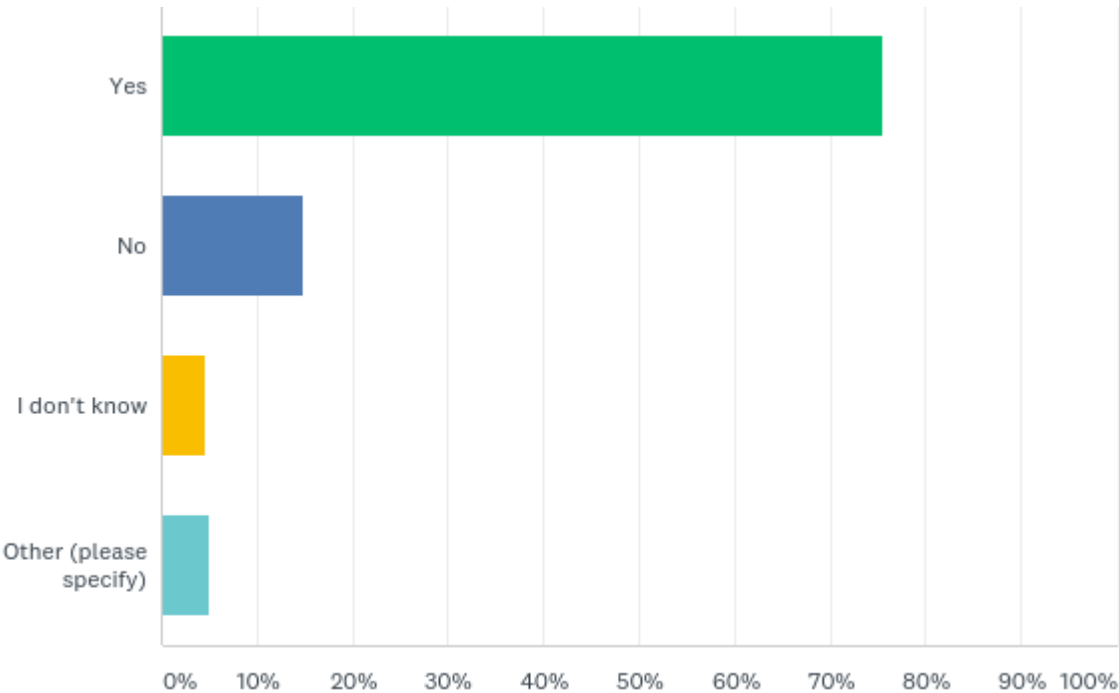
▶ Answered: 2,003 Skipped: 92

Answer Choices	Responses	
Less than an hour	16.53%	331
1-3 hours	27.86%	558
3-5 hours	15.83%	317
5-8 hours	8.89%	178
More than eight hours	2.35%	47
I did not evacuate	14.18%	284
Other (please specify)	14.38%	288
Total		2,003

Q7: Does your family have a plan for how you will handle emergencies in the future?

▶ Answered: 1,998 Skipped: 97

Answer Choices	Responses	
Yes	75.43%	1,507
No	14.81%	296
I don't know	4.70%	94
Other (please specify)	5.06%	101
Total		1,998

Q8: Based on your experience with the Oroville spillway incident evacuation, are you likely to comply with an evacuation notification in the future?
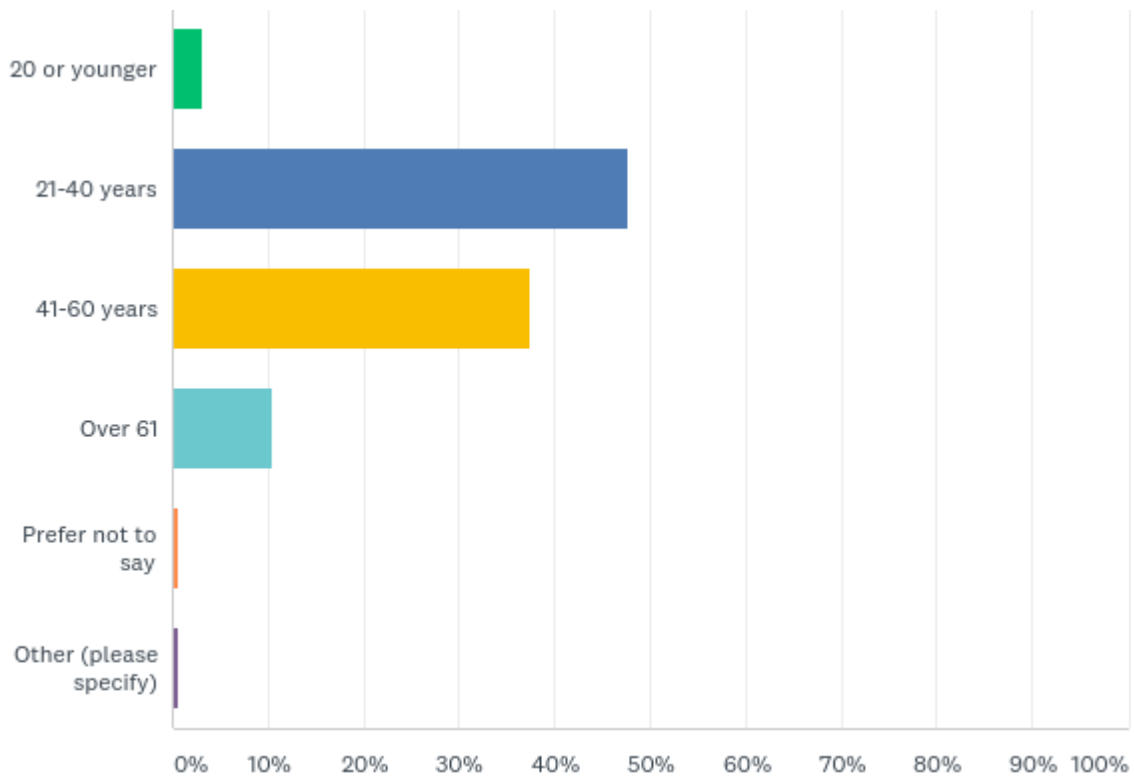
▶ Answered: 1,996 Skipped: 99
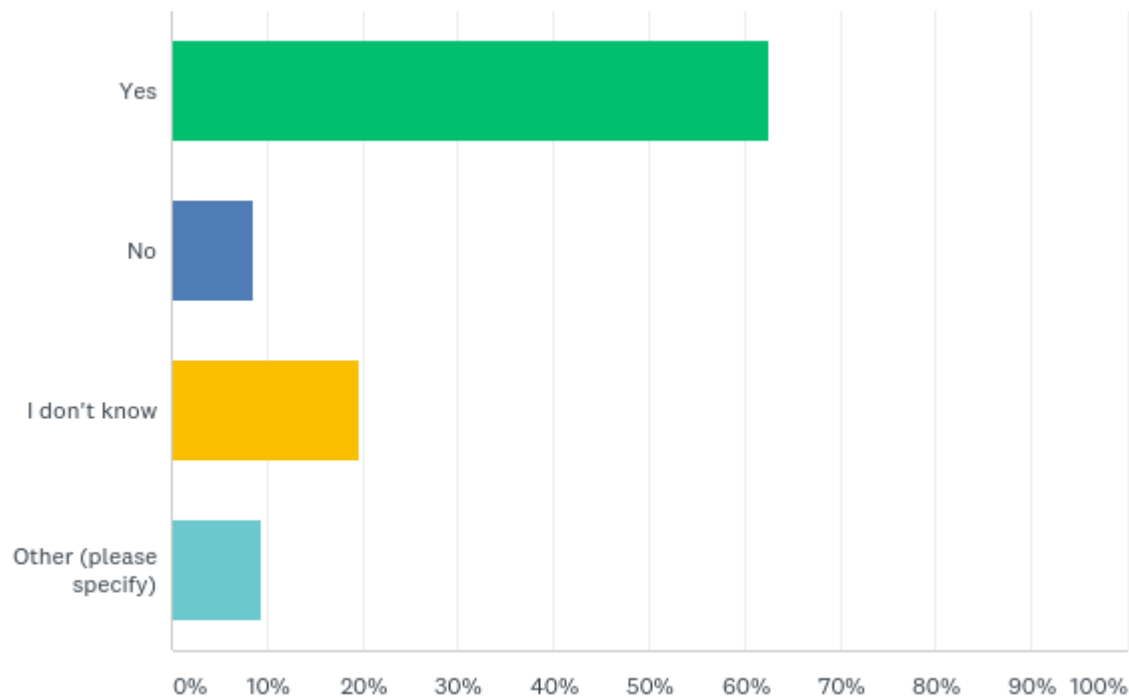
Answer Choices	Responses	
Yes	62.47%	1,247
No	8.57%	171
I don't know	19.64%	392
Other (please specify)	9.32%	186
Total		1,996

Q9: What is your age? (Please choose one)

▶ Answered: 1,986 Skipped: 109

Answer Choices	Responses	
20 or younger	3.07%	61
21-40 years	47.78%	949
41-60 years	37.36%	742
Over 61	10.52%	209
Prefer not to say	0.65%	13
Other (please specify)	0.60%	12
Total		1,986

Q10: Is English the only language spoken at home?

▶ Answered: 1,979 Skipped: 116
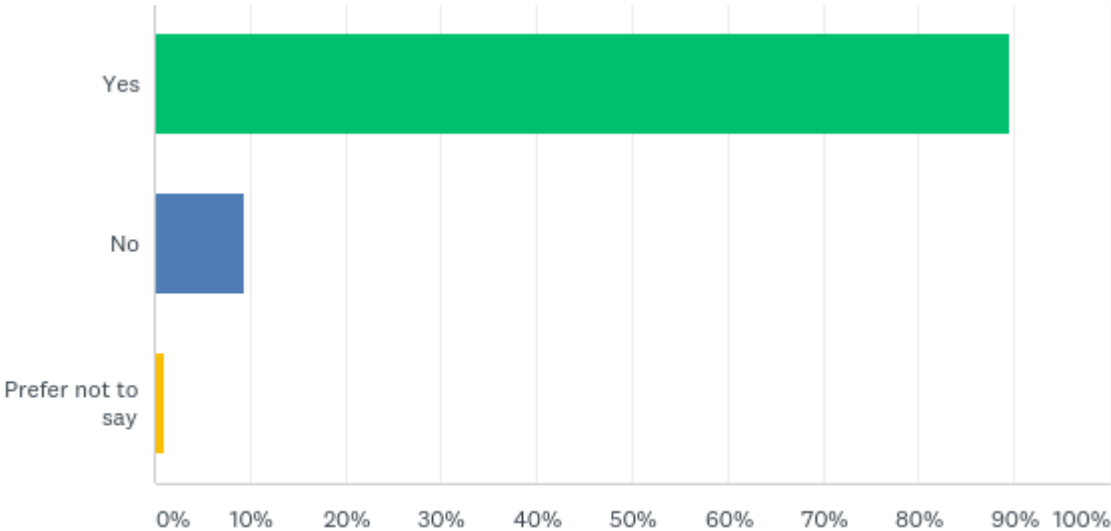
Answer Choices	Responses	
Yes	89.64%	1,774
No	9.40%	186
Prefer not to say	0.96%	19
Total		1,979

Q11: How many individuals reside at home?

▶ Answered: 1,975 Skipped: 120
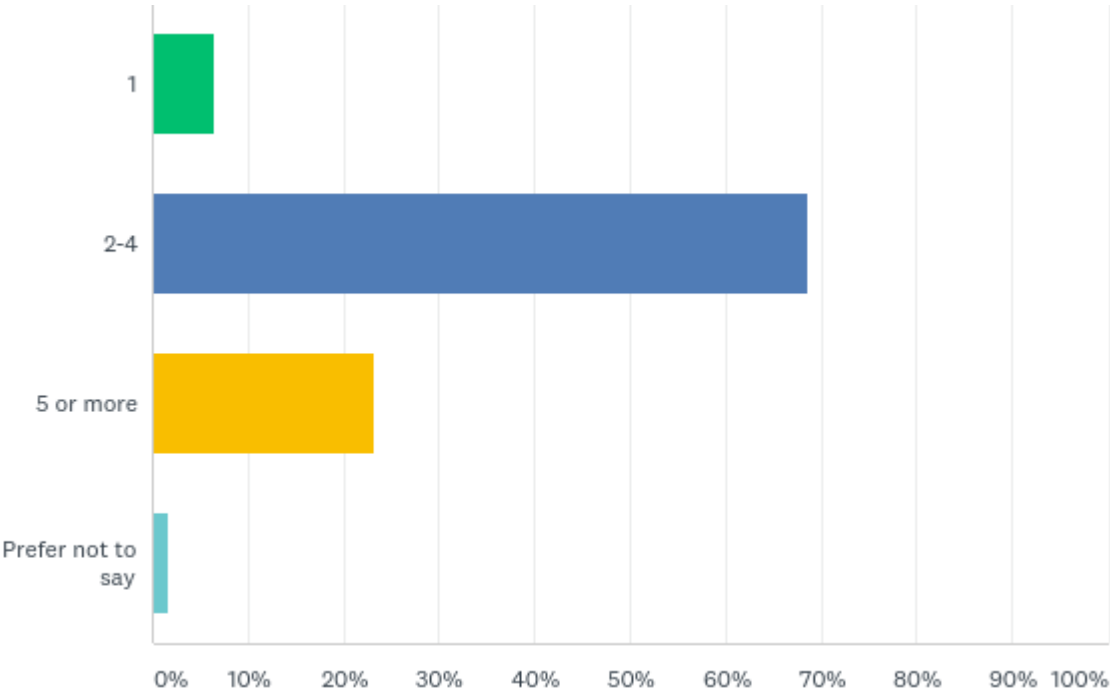
Answer Choices	Responses	
1	6.53%	129
2-4	68.61%	1,355
5 or more	23.29%	460
Prefer not to say	1.57%	31
Total		1,975

XII. Team Listing

The DHS AEP Community Resilience Team included the following individuals:

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With special thanks to our two subject matter experts:

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Butte County Sheriff
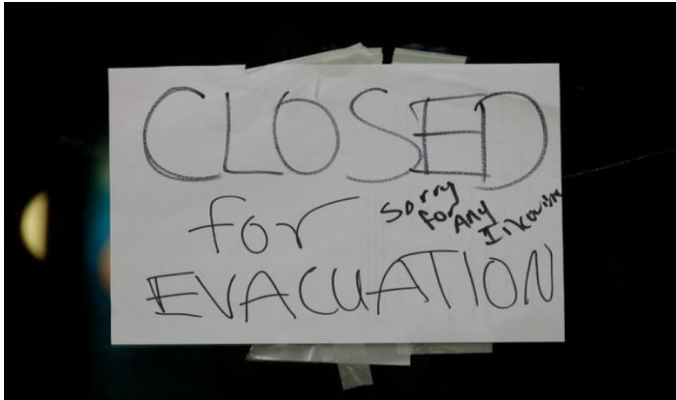57 mins · 🌐

This is an evacuation order.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

A hazardous situation is developing with the Oroville Dam auxiliary spillway. Operation of the auxiliary spillway has lead to severe erosion that could lead to a failure of the structure. Failure of the auxiliary spillway structure will result in an uncontrolled release of flood waters from Lake Oroville.

In response to this developing situation, DWR is increasing water releases to 100,000 cubic feet per second.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

This in NOT A Drill. This in NOT A Drill. This in NOT A Drill.

CLOSED for EVACUATION sorry for any Inconv

6:36   SPILLWAY EVACUATIONS   DEVELOPING STORY   KTVU